APPLICATION FOR PATENT

TITLE: BATH LIFTING SYSTEM

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SPECIFICATION

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part of co-pending U.S. application Serial No. 10/703,942, filed November 7, 2003, which is a continuation-in-part of U.S. application Serial No. 10/254,358, filed September 25, 2002, now U.S. Patent No. 6,643,861, which is a continuation-in-part of U.S. application Serial No. 10/085,197, filed February 27, 2002, now U.S. Patent No. 6,643,860, which is a continuation-in-part of application Serial No. 09/550,307, filed April 14, 2000, now U.S. Patent No. 6,397,409, the entirety of each of these applications are hereby incorporated by reference herein.

FIELD OF THE INVENTION

[0002] This invention relates generally to a bath system for raising and lowering an individual in and out of a bath, and more particularly, to a bath system with a seat and a lifting device, where the lifting device is positioned within the bath, substantially out of sight.

BACKGROUND OF THE INVENTION

[0003] Bath lifting systems have been available in the past to raise and lower individuals in and out of a bath. For example, U.S. Pat. No. 2,361,474 proposes a bath lifting system for raising and lowering an individual in and out of a bath using two exposed U-shaped crankshafts. A table spanning the shafts is connected to the bights of the U-shaped crankshafts. The crankshafts rotate in unison to rotate the table from a lowered position within the bath to a raised or extended position out of the bath.

[0004] Another bath lifting system is proposed in U.S. Pat. Re. No. 33,624. This system proposes a lifting device on the outside of the bath connected to a seat support member that extends through the bath wall. In particular, the seat support member extends through an

[0005] Yet another bath lifting system is proposed in U.S. Pat. No. 5,146,638. This system proposes a telescoping lifting column which is positioned in an upright position through one end of the upper rim or top of a bath. The lifting column includes a first actuator that vertically raises and lowers the seat in and out of a bath. A second actuator then swivels or rotates the lifting column about its cylindrical axis to position the front portion of the seat from a central position in the bath to a position over the rim or top of the bath. If desired, the seat can be swiveled through a smaller angle from its central position in the bath for transfer from a wheelchair to the seat.

[0006] Yet another bath lifting system is proposed in U.S. Pat. No. 3,280,409. This retrofit bath lifting system proposes a cylindrical lift housing having a piston, with the housing positioned in an upright position above one end of the upper rim or top of the bath. The piston is connected to a movable seat via a pulley and cable for moving the seat between a lowered position in the bath and a raised position above the bath. A pair of wheels roll up and down the outside of a guide post for guided rearward movement of the seat as the seat raises above the bath. The seat and cylindrical lift housing can rotate together when the seat is in the raised position to facilitate entry into and exit from the bath.

[0007] U.S. Pat. No. 5,129,112 also proposes a retrofit bath lifting system. This system uses two wheel assemblies attached to a mechanical actuator. The wheel assemblies roll up and down a support surface for guided rearward movement of the seat as the seat raises above the bath. The seat and the mechanical actuator with its attached wheel assemblies can rotate together when the seat is in the raised position to facilitate entry into and exit from the bath.

[0008] Many other bath lift systems, available in the past, have an appearance that is bulky and mechanical. In particular, exposed lifting devices located adjacent to the bath are not considered aesthetically appealing. In the lifting devices positioned out of sight behind a side bath wall and extending through the upper rim of the bath, dual actuators, electronic circuitry and mechanical parts are proposed to provide a two step movement to first raise the seat and then swivel the seat, even if only to swivel the seat a preferred smaller angle from a central position to position the seat for transfer from a wheelchair. (See '638 Patent, col. 3, ln. 62 to col. 4, ln. 41). Also, support members which extend through an elongated opening or slot in the bath wall, that begin at the bottom of the bath in the drain area, are particularly susceptible to seal wear and resulting water leakage from the area where fluids collect caused by the sliding movement of the member that extends through the wall.

[0009] Therefore, an aesthetically appealing lifting device, substantially covered behind the seat, would be desirable. Moreover, a bath lifting system substantially covered behind a

lift seat that provides positioning of the seat from a central position to a position along side of the rim or top of the bath for transfer from a wheelchair would be desirable. Furthermore, a bath lifting system that could be retrofitted into an existing bath would be desirable. Further, a bath lifting system controlled by a wireless remote device would be desirable. Also, it would be desirable to use a hinge with the retrofit embodiment to facilitate both alternative connections of the bath lifting system to a bath, wall or other structural member, and a force compensation system to provide access to the bath adjacent to the bath lifting system and for safety.

SUMMARY OF THE INVENTION

[0010] According to the invention, a composite bath embodiment that substantially covers the bath lifting system behind the seat while positioning the seat from a central position to a laterally offset position along the side of the rim of the bath for transfer from a wheelchair is disclosed. A retrofit embodiment of the invention is also disclosed that uses a frame that allows the system to be retrofitted into an existing bath with little or no modifications to the bath. Both the composite bath embodiment and the retrofit embodiment are disclosed for straight up or laterally offset use. Also, a retrofit embodiment force compensation system provides access to the bath adjacent the bath lifting system and safety while providing the retrofit embodiment with alternative connections. A preferred retrofit embodiment is disclosed in which guide members, attached to a piston of a hydraulic cylinder, move up and down opposed guide surfaces for guided rearward movement of the seat as the seat raises above the bath. The seat rotates relative to the stationary hydraulic cylinder and its attached guide members when the seat is in the raised position to facilitate entry into and exit from the bath.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The object, advantages, and features of the invention will become more apparent by reference to the drawings which are appended hereto and wherein like numerals indicate like parts and wherein an illustration of the invention is shown, of which:

FIG. 1 is a cut-away side elevational view of an alternative composite embodiment A of the bath lifting system with the seat in the lowered position;

FIG. 2 is a view similar to FIG. 1 with the seat in the raised position;

FIG. 3 is a top view of the bath lifting system as shown in FIG. 1, with the seat also shown in phantom view in its rotated entry/exit position;

FIG. 4 is a view taken along line 4–4 of FIG. 1;

FIG. 5 is a view taken along line 5–5 of FIG. 2, with the seat also shown in phantom view in its rotated entry/exit position;

FIG. 6 is a side elevational view taken along line 6–6 of FIG. 3 showing the lifting power system of the composite embodiments;

FIG. 7 is a side elevational view, similar to FIG. 6, showing the seat in the raised position;

FIG. 8 is a perspective view of the alternative composite embodiment A looking down, and towards the back of the bath, with the seat removed, to better illustrate the lifting device;

FIG. 9 is a view of the bath taken along line 9-9 of FIG. 8 showing a cross section view of the seat rotation assembly;

FIG. 10 is a cut-away side elevational view of an alternative composite embodiment B of the present invention showing the seat in the lowered position;

FIG. 11 is a view similar to FIG. 10 of the alternative composite embodiment B of the present invention showing the seat in the raised position;

FIG. 12 is a side elevational view of an alternative composite embodiment C of the present invention showing the seat in the raised position and another lifting power system;

FIG. 13 is a cut-away side elevational view of an alternative straight up retrofit embodiment D with the seat in the lowered position along with a cut-away of its lifting power system;

FIG. 14 is a partial cut-away side elevational view of the alternative straight up retrofit embodiment D taken along the longitudinal center of the bath;

FIG. 15 is a view of the alternative straight up retrofit embodiment D taken along line 15-15 of FIG. 14 to better show its guiding assembly and lifting device;

FIG. 16 is a view of the alternative straight up retrofit embodiment D taken along line 16-16 of FIG. 14 to better show the rotation assembly and locking pin;

FIG. 17 is a view of the alternative straight up retrofit embodiment D similar to FIG. 14 showing the seat in the raised position;

FIG. 18 is a view of the alternative straight up retrofit embodiment D similar to FIG.

FIG. 19 is a top view of the alternative straight up retrofit embodiment D with the seat pivoted forward to its access position as shown in FIG. 18;

FIG. 20 is an enlarged cut-away side elevational view of the alternative straight up retrofit embodiment D seat rotation assembly;

FIG. 21 is a section view of the seat rotation assembly taken along line 21-21 of FIG. 20;

FIG. 22 is a chart for the alternative straight up retrofit embodiment D showing a comparison of the pressures and forces generated throughout the system, including the force "F" generated by each of the dual lift cylinders of the lifting device as the seat is moved between the lowered and the raised position;

FIG. 23 is a diagram for the alternative straight up retrofit embodiment D showing the vector forces generated at the guiding arm's middle connection point and the guiding arm's outer end as the seat is moved between the lowered position and the raised position;

FIG. 24 is a chart for the alternative straight up retrofit embodiment D showing the force "F" generated by the combined dual lift cylinders of the lifting device, and the forces "P" and "P/2" occurring at 90° angles to the guiding arms at the middle connection point and the outer end, respectively, and the vertical force "L" occurring at the end of the guiding arm;

FIG. 25 is an enlarged broken side elevational view of the lifting power system of the alternative straight up retrofit embodiment D to better show the details of the primary and secondary pistons of the lifting power system;

FIG. 26 is a top view of an alternative straight up retrofit embodiment E in the raised position and the seat removed to better show the frame extension below the seat and the two lateral stabilizers engaged with the side walls of the bath;

FIG. 27 is a cut-away side elevational view of the alternative straight up retrofit embodiment E, shown in FIG. 26, with the seat in place;

FIG. 28 is a cut-away partial side elevational view of an alternative straight up retrofit embodiment F using a bellows with the seat in the lowered position;

FIG. 29 is a view of the alternative straight up retrofit embodiment F, similar to FIG. 28, showing the seat in the raised position;

FIG. 30 is an enlarged detail cut-away view of the bellows of the alternative straight up retrofit embodiment F with the bellows in the collapsed or folded position;

FIG. 31 is a view similar to FIG. 30 but with the bellows in a partially deployed or partially expanded state;

FIG. 32 is a partial view of a side wall of the bellows of alternative straight up retrofit embodiment F in the fully deployed or expanded state;

FIG. 33 is a top view of an alternative composite embodiment G with the rotatable member positioned in a recess in the bath wall behind the seat and showing the seat in the lowered position;

FIG. 34 is a side elevational view of the alternative composite embodiment G showing the seat in the lowered position;

FIG. 35 is a perspective view of the alternative composite embodiment G looking down, and towards the back of the bath, from a location outside the bath, with the seat in the lowered position;

FIG. 36 is a perspective view of an alternative laterally offset retrofit embodiment H looking down and towards the back of the bath, with the seat removed;

FIG. 37 is a cut-away length view of the alternative laterally offset retrofit embodiment H looking in the direction of the back of the bath showing the seat in a raised position;

FIG. 38 is a cut-away side elevational view of the alternative laterally offset retrofit embodiment H of the bath lift system with the seat in the lowered position;

FIG. 39 is a section taken along line 39-39 of FIG. 38 to better show the telescoping armrest;

FIG. 40 is a side elevational view of an alternative lifting power system for the retrofit embodiments D and H including an additional primary cylinder bushing shown in a fully retracted position;

FIG. 41 is the lifting power system of FIG. 40 with the primary cylinder bushing shown in its fully extended position;

FIG. 42 is the lifting power system of FIGS. 40 and 41 with both the primary cylinder bushing and the primary piston in their fully extended positions;

FIG. 43 is a chart of the lifting power system of FIGS. 40-42 showing the corresponding vertical force "L" occurring at the end of the guiding arm relative to the minimum force "L" required;

FIG. 44 is a schematic diagram of a self-pressurized system that can be used with all the embodiments A-H;

FIG. 45 is an enlarged detail cut-away view of the fastening hinge plate in the horizontal position for attaching the bath lifting system to

FIG. 46 is an enlarged detail cut-away view of the fastening hinge plate in the vertical position for attaching the bath lifting system to a structural member;

FIG. 47 is a view taken along line 47-47 of FIG. 46, better showing the reinforcing members used for attaching the retrofit embodiment force compensation system to a structural member;

FIG. 48 illustrates an obstruction, shown in phantom view, positioned beneath the bath lifting system, shown in cut-away side elevational view, with the frame of the retrofit embodiment engaging the bath bottom;

FIG. 49 illustrates the frame of the retrofit embodiment bath lifting system pivoted away from the back bath wall and disengaged with the bath bottom after engaging the obstruction;

FIG. 50 is a cutaway side view of a preferred laterally offset retrofit embodiment J, with the seat in a lowered position;

FIG. 51 is a cutaway end view taken along line 51-51 of FIG 50 of the preferred laterally offset retrofit embodiment J, illustrating its guiding assembly and lifting device;

FIG. 52 is a section view of the guiding assembly and lifting device taken along line 52-52 of FIG. 51;

FIG. 53 is a cutaway side view of the preferred laterally offset retrofit embodiment J, with the seat in a raised rearward position; and

FIG. 54 is a schematic of a motor control system that can be used with the preferred laterally offset retrofit embodiment J.

OVERVIEW

[0012] The bath lift system of the present invention is shown in the Figures (FIGS.) In particular, the preferred laterally offset retrofit embodiment J is shown in FIGS. 50-54; the alternative composite embodiment A, without a back recess 434, is shown in FIGS. 1-9; the alternative composite embodiment B, using a bellows member 148, is shown in FIGS. 10-11; the alternative composite embodiment C, with a power piston system 184 and power cam system 186, is shown in FIG. 12; the preferred composite embodiment G of the bath lift system is shown in FIGS. 33-35; the alternative straight up retrofit embodiment D is shown in FIGS. 13-25; the alternative laterally offset retrofit embodiment H is shown in FIGS. 36-43; the alternative straight up retrofit embodiment E, with frame extension 406, is shown in FIGS. 26 and 27; the alternative straight up retrofit embodiment F, with alternative bellows

member 422, is shown in FIGS. 28-32; and a self-pressurized system that can be use with all the embodiments A-H is shown in FIG. 44. (No embodiment is labeled "I.") FIGS. 45-47 show the retrofit embodiments provided with a hinge, generally indicated at 604, to allow alternative connections of the bath lifting system. FIGS. 48 and 49 show a retrofit embodiment force compensation system that allows the bath lifting system to compensate in response to a force exerted by obstruction O. It is contemplated that the preferred guiding assembly, lifting device, and lifting power system of FIGS. 50-54 can be adapted for use with the composite embodiment of the bath lifting system.

[0013] Note that the term "straight up" is used herein to distinguish from "laterally offset" and does not indicate that the movement of the seat assembly has only vertical components, but rather indicates that the movement does not have a lateral component relative to the side wall of the bath, even though the movement may have forward or rearward components.

DETAILED DESCRIPTION OF THE ALTERNATIVE COMPOSITE EMBODIMENT A:

[0014] The alternative composite embodiment A, shown in FIGS. 1-9, comprises: a bath, generally indicated at 20, a seat assembly, generally indicated at 22, guiding assembly, generally indicated at 26, lifting device, generally indicated at 28, and lifting power system, generally indicated at 30. As shown in the Figures, bath 20 includes bath walls 24A, 24B, 24C, 24D, and bath bottom 24E, along with other standard bath features including openings 24F and 24G for drains. Alternative composite embodiment A includes a seat recess 36 in the bath bottom 24E and channel recess 38 for communicating fluid from the seat recess 36 to the drain opening 24F. Other recess formations may be used or no recess formations could be used. Also, other embodiments may relocate standard bath features, such as the drain, or may modify standard bath features, for example, by using multiple drains. In addition, other embodiments may use a hot tub, pool, a whirlpool bath or shower in place of a bath tub, all of which are considered a bath.

[0015] Seat assembly 22, preferably fabricated from a non-corrosive material such as plastic, can be seen in FIGS. 1-7. Seat assembly 22 is sized and positioned to substantially cover both the guiding assembly 26 and the lifting device 28, when seat assembly 22 is in the lowered position. As best shown in FIGS. 2, 8 and 9, seat assembly 22 is rotatably attached to a seat rotation assembly, generally indicated at 40, via seat 22A. As best shown in FIG. 9,

post 50 via securing ring 54. Rotor 48 rotates within housing 44 contacting bearings 52 and bushings 58. Housing 44 is preferably integral with cantilevered seat bracket 46, which is in turn attached to guiding assembly 26. Other embodiments may not substantially obscure or cover the view of guiding assembly 26, such as with an opening in seat back 22B. In addition, other embodiments may exclude rotation assembly 40 and directly fixedly attach the seat 22A directly to the seat bracket 46.

[0016] As best shown in FIGS. 2, 3 and 5, locking pin, generally indicated at 60, along with pin holes 62 and 64 in rotation assembly 40 are used to lock seat assembly 22 into predetermined desired positions. Locking pin 60 has a pin head 75, a left and right (when viewing FIG. 2) shaft portions, 66 and 68, respectively, separated by collar 70 therebetween. Left shaft portion 66 extends through seat extension 72. Right shaft portion 68 extends through seat opening 74. Collar 70 is urged away from seat opening 74 by a coil spring 76 compressed between collar 70 and seat opening 74 to urge the end of locking pin 60 to contact the cylindrical exterior 40A and the desired pin holes 62 and 64 of rotation assembly 40. Locking pin hole 62, located on the front cylindrical exterior 40A of rotation assembly 40, is located in the rotation path of locking pin 60. When the desired pin hole is aligned with locking pin 60, coil spring 76 urges locking pin 60 to be received in selected pin hole to lock the seat in the desired position as shown in FIG. 2. Locking pin hole 64, preferably located 90° from hole 62 on the side of the cylindrical exterior 40A of rotation assembly 40, is also located in the rotational path of locking pin 60. When the locking pin 60 engages pin hole 64, the seat assembly 22 is locked in the lateral position, as shown in phantom view in FIGS. 3 and 5. Other alternative embodiments may use other forms of locking mechanisms and locked positions.

[0017] Guiding assembly 26 of the alternative composite embodiment A is best shown in FIGS. 1, 2, 4, 5, 7 and 8. In the alternative composite embodiment A, the guiding assembly 26 is made up of first set of arms 34A and 34B and second set of arms 80A and 80B, and the entire assembly is mounted to wall 24A at an angle Ø, as best shown in FIG. 5, with respect to the bottom 24E of bath 20. The angle Ø at which the arms are attached is such that when the seat is in the lowered position, the seat is located substantially along the longitudinal axis D of the bath, as best shown in FIG. 3, and when the seat is in the raised position, the seat overlaps the top of the side wall 24D of the bath, as best shown in FIG. 5. In the alternative composite embodiment A, both sets of arms are attached at one end to the bath wall 24A and at the other end to seat bracket 46. As best shown in FIGS. 1, 2, 4 and 5, the second set of arms 80A and 80B are pivotally attached at one end to upper wall rod 82 and at the oth[illegible]

to upper seat rod 84. Upper wall rod 82 is, in turn, attached to bath wall 24A via attachment blocks 81A and 81B. The first set of arms 34A and 34B are fixedly attached at one end to rotatable member 32, and, at the other end, to lower seat rod 86. Rotatable member 32 is attached to bath wall 24A via attachment blocks 83A and 83B. Other alternative embodiments may use a single first arm and a single second arm, and others only a structurally stable first set of arms, and yet others with only a single first arm. Also, other alternative embodiments may mount any existing first or second sets of arms straight up horizontally, rather than at an angle Ø to the bottom of the bath. Other embodiments may not use rods that extend the full width of the bath, but rather, only extend between the side of the bath and the connection arm(s). Yet even other alternative embodiments may utilize different types of guiding assemblies which transform rotational movement into vertical displacement of the seat.

[0018] Lifting device 28 can best be seen in FIGS. 1, 2, 3, 4, 5, 6, 7, and 8. In the alternative composite embodiment A, as best shown in FIGS. 4 and 5, the lifting device 28 is rotatable member or steel rod 32. The rod 32 is positioned in the bath 20 using lower wall opening 88, upper wall opening 90, washer 92, and rotatable member seal 93. The seal 93 is preferably fabricated from an elastomer, such as rubber. The rotatable member 32 extends from upper wall opening 90 and through lower wall opening 88. Upper wall opening 90 is located above lower wall opening 88 such that rotatable member 32 is positioned at angle Ø with respect to the bottom 24E of bath 20. Washer 92 is positioned in bath wall 24D such that washer 92 aides the rotation of rotatable member 32 relative to wall opening 90. Rotatable member seal 93 sealing opening 88 provides a water tight seal about rotatable member 32. Since seal 93 surrounds cylindrical rod 32, the rotation of rod 32 about its cylindrical axis does not significantly distort the seal 93. Thus, the seal 93 is maintained under constant static pressure which is an advantageous condition for maintaining a good seal. Other embodiments may use upper wall rod 82 as the lifting device and in doing so may alleviate the need for seal 93 by locating the lowest wall opening above the water line of the bath. As best shown in FIGS. 6 and 7, leverage mechanism, generally indicated at 98, attaches to the portion of rotatable member 32 which extends though lower wall opening 88 to provide lifting device 28 its lifting force. Yet, other embodiments may use entirely different lifting devices, including such mechanisms which are not connected with the guiding assembly, or such mechanisms which require no proposed openings in bath walls 24, as discussed below in the preferred retrofit embodiment, the alternative retrofit embodiments,

[0019] An alternative lifting power system 30 is best shown in FIGS. 6 and 7. The lifting power system 30 has the following four components: a fluid control system, generally indicated at 94, a drive system, generally indicated at 96, a leverage system, generally indicated at 98, and a return mechanism, generally indicated at 168. The fluid control system 94 controls the in-flow and the out-flow of fluid, such as liquid, into the drive system 96 and, therefore, controls the lifting and raising of the seat assembly 22. The drive system 96 transforms the fluid pressure into a mechanical linear force. The leverage system 98 transforms mechanical linear force into a torquing force applied to rotatable member 32. The return mechanism 168 supplies a force to lower seat assembly 22 to its lowered position. In the alternative composite embodiment A, the lifting power system 30 is located out of view, within the walls of bath 20. For easy access to the components of lifting power system 30, a removable outer panel 25, as best shown in FIGS. 4 and 5, can be incorporated into the bath 20. Other embodiments may place the lifting power system within the adjacent bathroom walls, or, if necessary, even expose such a system in the bathroom itself. Other alternative embodiments may even use other forms of lifting power systems that provide torque to rotatable member 32, for example, an electric motor.

[0020] As best shown in FIGS. 6 and 7, the fluid control system 94 of the alternative composite embodiment A is made up of the following components: a feeder pipe 100, a control valve 102, a discharge pipe 104, a control knob 106, a needle valve 180, a needle valve adjustment mechanism 182, and a control pipe 108 between needle valve 180 and a chamber inlet 110. Feeder pipe 100 communicates fluid which lifts seat assembly 22. In alternative composite embodiment A, the fluid used is preferably water supplied under standard tap water pressure. However, it is contemplated that the fluid could be pressurized by a pump or by a hydraulic pressure multiplier, as discussed below in detail. In addition, and as shown in FIGS. 6 and 7, as a safeguard, drip pan type mechanism 125 may be used under lifting power system 30, and under all other components which may leak fluids, such as lower wall opening 88, or any other component which might accumulate and drip condensation. Other alternative embodiments may use other forms of fluid control systems that control the flow of fluid into and out of fluid control system 94 or the drive system 96. Also, it is contemplated that other embodiments may utilize other fluids other than water, such as other liquids or even gaseous materials in place of tap water.

[0021] Control valve 102 controls the flow of fluid between feeder pipe 100 and control pipe 108. Control knob 106 operates control valve 102 to allow fluid to enter into, and exit from, the drive system 96 which, in turn, raises and lowers seat assembly 22. Control pipe

108 communicates fluid into and out of drive system 96. Discharge pipe 104 empties fluid from drive system 96 into bath 20 by moving the control knob 106 so the control valve 102 is in the discharge position, as shown in FIG. 6. It is contemplated that the fluid control system 94 would be initially adjusted through the manipulation of needle valve adjustment mechanism 182, such that when control valve 102 is fully open, the restricted setting of needle valve 180 would result in the bather descending at a comfortable rate of speed. It should be noted that control knob 106 can be moved such that control valve 102 is in misalignment with feeder pipe 100 and control pipe 108 allowing the operator to further control the volume of fluid entering or exiting pipe 108, and as a result, control the speed at which seat assembly 22 rises or lowers. FIG. 7 shows control valve 102 in the lifting power position, where seat assembly 22 would rise at its fastest rate. The diameter of control valve 102, feeder pipe 100, and/or control pipe 108, should be sized such that the resulting seat movement moves at rate that is within a comfort level for bathers.

[0022] As best shown in FIGS. 6 and 7, drive system 96 comprises a chamber housing 111, a chamber 112, a piston rod 114, a piston head 116, a rod seal 118, a rod connector 120, a chamber housing mount 122, and a piston head seal 124. Chamber housing 111 defines chamber 112. Chamber 112 is filled and emptied of fluid from the fluid control system 94 causing piston head 116 to travel within chamber 112. Piston head 116 and piston head seal 124 provide a seal between the filled and unfilled portion of chamber 112. Chamber housing 111 is secured to bath 20 via chamber housing mount 122. Piston rod 114 is connected to piston head 116 and moves linearly with the movement of piston head 116. Rod seal 118 provides a seal about the piston rod 114 at the exit point of chamber 112. Rod connector 120 connects the piston rod 114 to the leverage system 98. In the alternative composite embodiment A, as best shown in FIG. 6, the travel distance B of piston head 116 is greater than the distance A traveled by seat assembly 22, thus giving a leverage advantage to drive system 96 over seat assembly 22. Other alternative embodiments are contemplated that may use other forms of drive systems to transform fluid pressure into mechanical energy.

[0023] Continuing with FIGS. 6 and 7, the leverage system 98 of the alternative composite embodiment A comprises a pulley assembly 126, cam 128, cam cable 130, and cam cable connection 132. Pulley assembly 126 comprises a pulley wheel cable 134, pulley wheel 136, pulley wheel post 138, pulley body 140, pulley body cable connection 142, pulley wheel cable anchor 144, and anchor connection 146. Pulley wheel cable 134 is connected between rod connector 120 at the end of piston rod 114, and anchor connector 146 located on pulley wheel cable anchor 144. Pulley wheel cable 134 [illegible]

wheel 136 is rotatably attached to pulley body 140 on pulley wheel post 138. Cam cable 130 is attached between pulley body 140 at the pulley body cable connection 142, and cam 128 at cam cable connection 132. Since cam 128 is fixedly attached about rotatable member 32, any movement of cam cable 130 results in the rotation of cam 128 which, in turn, rotates rotatable member 32 to move seat assembly 22. Other alternative embodiments may utilize upper wall rod 82 as the rotatable member, with upper wall rod 82 only spanning between the wall connections and not extend into the side walls of the bath, and thus avoiding the need for any sealing means associated with opening 88 in the alternative composite embodiment A since the upper wall rod is accessible above the water line of the bath. Yet, other alternative embodiments may use other forms of leverage systems which transform a supplied mechanical energy into rotational energy.

[0024] Still continuing with FIGS. 6 and 7, the return mechanism 168 of the alternative composite embodiment A comprises a return cam 170, a spring 172, a return cam cable 174, a return cam cable connection 176, and a spring mooring 178. Spring 172 is connected at one end to spring mooring 178, and at the other, to return cam cable 174. Return cam cable 174 is, in turn, connected to return cam cable connection 176. Since return cam 170 is fixedly attached about rotatable member 32, any movement of return cam cable 174 results in the rotation of return cam 170 which, in turn, rotates rotatable member 32 to move seat assembly 22. Other alternative embodiments may use other configurations to supply the force needed to return seat assembly 22 to its lowered position, for example, a weight attached to seat assembly 22, such that gravitational force provides the force necessary to lower the seat, or a torsional spring attached to rotatable member 32, such that rotational force urges the seat in the lowering direction. In addition, alternative embodiments may use springs of different sizes and strength or may use cams with a different radius. Yet, other alternative embodiments may utilize a single cam to perform both the functions of cam 128 and return cam 170.

<u>USE AND OPERATION OF ALTERNATIVE COMPOSITE EMBODIMENT A:</u>

[0025] A typical bather, being wheelchair assisted, would typically leave the bath system with seat assembly 22 in its lowered position, as shown in FIG. 1. To transfer to the bath 20, bather wheels his or her chair along side of bath 20. The operator of the bath system then

108 into chamber 112. As water fills chamber 112, the water pressure forces piston head 116 along chamber 112 towards the bath wall 24C.

[0026] As shown in FIGS. 6 and 7, as piston head 116 travels along chamber 112, piston rod 114 and pulley wheel cable 134 move. Since pulley wheel cable 134 is threaded through pulley wheel 136 and anchored by pulley wheel cable anchor 144, the movement of pulley wheel cable 134 causes pulley wheel 136 to rotate and move in the same direction. The use of this leverage system 98 requires less force from the drive system 96 to lift seat assembly 22. The movement of cam cable 130 causes cam 128, return cam 170, fixedly attached to rotatable member 32 to rotate. Return mechanism 168 is also set into motion with the movement of cam cable 130, however, its operation is essentially inconsequential while seat assembly 22 is occupied with a bather, as the force supplied by return mechanism 168 is small in comparison to the weight of the bather. As shown in FIGS. 4 and 5, as rotatable member 32 rotates, guiding assembly 26, moves seat assembly 22 in a smooth fashion along a straight line path from its central location at or near the longitudinal axis D of the bath bottom 24E, as best shown in FIG. 3, to a location, as best shown in FIG. 5, where the side of seat assembly 22 is at or beyond the top of side wall 24D. The angle Ø of the path is preferably between 10° and 20° from the orthogonal of the bath bottom 24E. Preferably, Ø is 15°. In so moving, the arm sets 34A, 34B and 80A, 80B of guiding assembly 26 move in unison from a position pointing substantially towards the bottom 24E of bath 20 to a position pointing substantially away from the bottom 24E of bath 20 to raise connected seat 22A above the top of bath 20.

[0027] In its fully raised position, seat assembly 22 is at or beyond the top of the side wall 24D of bath 20, so that bather can transfer to seat assembly 22. To transfer to seat assembly 22, the bather maneuvers his or her wheelchair so that it is substantially parallel to the bath and next to the seat assembly 22. The bather then slides off the chair onto the ledge of bath 20 and/or, if capable, directly onto seat assembly 22. Then, the bather brings the bather's legs over side wall 24D and into bath 20.

[0028] As best shown in FIGS. 4, 5 and 6, and discussed above, once securely in seat assembly 22, control knob 106 is operated to release the water from chamber 112 and lower the bather into bath 20. The discharged water travels through control pipe 108 and discharge pipe 104 into bath 20. During this process, seat assembly 22, guiding assembly 26, lifting device 28, and lifting power system 30, all reverse direction. During the lowering mode, the bather sitting on the seat assembly 22 experiences a constant and smooth descent along a straight line path away from the side 24D of bath 20, towards the central position longitudinal

axis D of the bath bottom 24E. When seat assembly 22 has been properly lowered, the bather can begin bathing. The filling of the bath with bath water may be done at any point before, during or after this process, or, if a shower is desired, may not be filled at all. If the seat assembly 22 is used in conjunction with a shower, the seat may be stopped in any desired position along the path that seat assembly 22 travels. Allowing the operator to choose to stop seat assembly 22 in any location along the path of seat assembly 22, i.e., an infinite number of locations, the bather can choose the most comfortable position. For example, the bather may want the seat slightly elevated while taking a shower as compared to the lowest position to be more fully submerged while taking a bath. To stop the seat in any position along the path traveled by seat assembly 22, the operator need only position control knob 106 such that control valve 102 is in a position that it does not communicate control pipe 108 to either discharge pipe 104 or feeder pipe 100.

[0029] To allow the bather to exit bath 20, the operator simply follows the steps described earlier to position the seat for transfer. However, now the operator operates the control knob 106 while the bather is in seat assembly 22. The operator and bather can be different or the same person. While exiting bath 20, seat assembly 22 ascends smoothly, in one continuous straight line movement, along a proportional angular path, from the lowered position at or near the longitudinal axis D of the bath bottom 24E, to a raised position at or above the side of bath 20. Once fully raised, the bather reverses his/her earlier movements to transfer back into the wheelchair. Once in the chair, the operator would use control knob 106 to return the seat assembly 22 to its lowered position. To lower the unoccupied seat assembly 22, the operator simply follows the steps described earlier for lowering the seat. However, with the absence of a bather from seat assembly 22, the additional force generated by return mechanism 168 assist the return of seat assembly 22, guiding assembly 26, lifting device 28, and lifting power system 30 to their respective positions when seat assembly 22 is in its fully lowered position.

[0030] Rotation assembly 40 allows for the rotation of seat assembly 22 at a location above the top of bath 20. The operation of this mechanism has not been fully described, as seat assembly 22 has only been shown in the rotated position with phantom views, but may be useful for bathers. It is contemplated that bathers, not in wheelchairs, could mount the seat assembly 22 when rotated to face the side of the bath, as shown in phantom view in FIGS. 3 and 5.

ALTERNATIVE COMPOSITE EMBODIMENT B:

[0031] Turning now to the alternative composite embodiment B shown in FIGS. 10-11, the alternative composite embodiment B utilizes similar component parts to the alternative composite embodiment A, including bath 20, seat assembly 22 and guiding assembly 26, but includes an alternative bellows member 148. The bellows member 148 includes an upper connector ring 150, a lower connector ring 152, a bellows casing 154, and a bellows inlet member 156. This alternative embodiment includes the additional feature of bellows recess 158 in the bath bottom 24E. The bellows recess 158 provides adequate space below the seat when the bellows is in its compressed mode. The presence of bellows recess 158 may require a deeper channel recess 38 communicating between bellows recess 158 and the drain opening 24F, or alternatively another drain opening could be provided in bellows recess 158. Other embodiments may use a different recess formation or may have no recess formations at all.

[0032] Bellows casing 154 is attached between the seat 22A and the bottom 24E of bath 20 via upper ring 150 and lower ring 152. The lower ring 152 is located within bellows recess 158. Bellows inlet member 156 allows for fluid to move between the fluid control system 94 including the needle valve 180 (not shown in FIGS. 10 and 11), as previously described, and bellows member 148. As the bellows member 148 fills with a fluid, the bellows member 148 expands and raises seat assembly 22. Guiding assembly 26 controls the direction that seat assembly 22 moves, as movement is imparted to seat assembly 22 by expanding bellows member 148. Here, unlike the alternative composite embodiment A, rotatable member 32 is a passive rotatable member, that does not need to extend through any bath wall, like the other above-described guiding assembly rods 82, 84 and 86. With this exception, the guiding assembly, in this alternative embodiment, is essentially the same as the one in the alternative composite embodiment A. Other embodiments may use other guiding assemblies, such as, the use of a simple guide pole or poles that extend from the walls of the bath. Such a pole might be disposed within the bellows member 148 itself. Other embodiments may follow a path other than the described angular path, for example, the seat may rise at a 90° angle to the bottom 24E and, therefore, not have any lateral movement. Other embodiments may also place the bellows member 148 in a location other than below seat assembly 22. For example, the bellows may instead contact a guiding assembly connected to the seat, which, in turn, causes seat assembly 22 to move. In addition, other embodiments may use other forms of an expandable member, which when expanded, causes

the raising of seat assembly 22, for example, a balloon type member or the bellow described below and shown in FIGS. 28-32.

USE AND OPERATION OF ALTERNATIVE COMPOSITE EMBODIMENT B:

[0033] The bather mounts and dismounts seat assembly 22 in the same manner as described in the alternative composite embodiment A. However, as best shown in FIGS. 10 and 11, to raise seat assembly 22, an operator uses control knob 106 to initiate the flow of fluid, such as water, from feeder pipe 100 through control pipe 108 into alternative bellows member 148. As water fills bellows member 148, the water pressure expands bellows member 148.

[0034] As bellows member 148 expands, it pushes against seat assembly 22 and moves seat assembly 22 away from the bottom 24E of bath 20. Guiding assembly 26 guides seat assembly 22 along a smooth and continuous straight line proportional angular path from the longitudinal axis D of bath bottom 24E, to a location where the side of seat assembly 22 is at or beyond the top of side wall 24D. In so moving, the set of arms 34A, 34B and 80A, 80B of guiding assembly 26 move in unison from a position pointing substantially towards the bottom 24E of bath 20 to a position pointing substantially away from the bottom 24E of bath 20, and raise seat 22A above the top of bath 20.

[0035] To lower seat assembly 22, the operator moves control knob 106 to release water from bellows member 148 to discharge pipe 104 into bath 20. The weighted seat assembly 22, or, in case a bather is located thereon, the weight of a bather and the seat on bellows member 148 urges the water within bellows member 148 to be discharged into control pipe 108, through control valve 102 to discharge pipe 104 into bath 20. During the lowering mode, seat assembly 22 experiences a constant and smooth straight line decent along a proportional angular path away from the side 24D of bath 20, towards at or near the longitudinal axis D of the bath bottom 24E.

ALTERNATIVE COMPOSITE EMBODIMENT C:

[0036] Turning now to the alternative composite embodiment C shown in FIG. 12, the alternative composite embodiment C utilizes similar component parts as those found in the alternative composite embodiment A except that lifting power system 30 is significantly altered. Although the fluid control system 94 and the return mechanism 168 have remained very similar to those in the alternative composite embodiment A, the drive system 96 and the

leverage mechanism 98 of the alternative composite embodiment A have been replaced with an alternative lifting power system comprising a power piston system 184 and power cam system 186, respectively.

[0037] The power piston system 184 comprises a power piston housing 188, a power piston chamber 190, a power piston rod 192, a power piston head 194, a power piston rod seal 196, a power piston rod connector 198, a power piston housing mount 200, and a power piston head seal 202. A power piston housing 188 defines power piston chamber 190. Power piston chamber 190 is filled and emptied of fluid from the fluid control system 94, through power inlet member 210, causing power piston head 194 to travel within power piston chamber 190. Power piston head 194 and power piston head seal 202 provide a seal between the filled and unfilled portion of power piston chamber 190. Power piston chamber 190 is secured to bath 20 via power piston housing mount 200. Power piston rod 192 is connected to power piston head 194 and moves linearly with the movement of power piston head 194. Power piston rod seal 196 provides a seal about the power piston rod 192 at the exit point of power piston chamber 190. Power piston rod connector 198 connects power piston rod 192 directly to the cam system 186 via power cam cable 204. The amount of liquid needed to fill piston chamber 190 is approximately 2.5 quarts.

USE AND OPERATION OF ALTERNATIVE COMPOSITE EMBODIMENT C:

[0038] The operation of alternative composite embodiment C is similar to that of the alternative composite embodiment A. However, power cam cable 204 is instead connected directly between power piston rod connector 198 and power cam connector 206, eliminating pulley assembly 126 of the alternative composite embodiment A. Rather than using a pulley assembly 126 to provide leverage to the force supplied by power piston system 184, power cam cable 204 provides a direct connection between power piston system 184 and power cam system 186. As shown in FIG. 12, as power piston head 194 travels along power piston chamber 190, power piston rod 192 and power cam cable 204 move along a linear path. The movement of power cam cable 204 causes both power cam 208 and fixedly attached rotatable member 32 to rotate. This rotation, as described in the alternative composite embodiment A, results in the lifting movement of seat assembly 22.

ALTERNATIVE COMPOSITE EMBODIMENT G:

[0039] Turning now to the alternative composite embodiment G, shown in FIGS. 33-35, the alternative composite embodiment G uses a bath 20''', along with similar component parts as those found in the alternative composite embodiment A except for the following: upper arms 80A''' and 80B''' pivot from slightly below the top of the back 24''' of the bath 20''', all arms 80A''', 80B''', 34A''' and 34B''' pivot from within back recess 434, in addition, and as shown in the alternative straight up retrofit embodiment H described below, seat assembly 22''', having an arm rest 320, pivots on rotation assembly 40' using a form of locking pin 60' having an engagement pin 338, a rotation block 336, a pivot pin 340 as well as an arm rest 320. In addition, and like the alternative straight up retrofit embodiment H, seat back 22B''' is pivotally connected such that the seat back 22B''' may tilt backwards allowing the bather greater mobility. Further, as best shown in FIGS. 34 and 35, seat back 22B''' does not extend above the top of bath 20''' when seat assembly 22''' is in its lowered position. Unlike bath 20 of the alternative composite embodiment A, bath 20''' is slightly larger being four inches wider, twelve inches longer and six inches deeper, and has a back bath wall 24A''' having a 15° angle away from the vertical, rather than the 30° angle found in bath 20.

[0040] Both the decreased angle of bath wall 24A''', and back recess 434 allow seat assembly 22''' to be located closer to the back 24''' of bath 20''', thus allowing greater distance between seat back 22B''' and the front 24C''' of the bath 20''', resulting in more legroom for the bather. The back recess 434 having back recess sides 436A and 436B, and back recess wall 438. As an alternative embodiment, rotatable member 32''' can penetrate back recess side 436B and be connected to back recess side 436A, with upper wall rod 82''' connected between the same back recess sides 436B and 436A. The rotatable member 32''' and upper wall rod 82''' may be mounted on an angle with respect to the bottom 24E''' of bath 20''' such that seat assembly 22''' follows a path, from the lowered position to the raised position, from the longitudinal center of the bath to a location near the top of side wall 24D'''. The lesser the slope of back wall 24A''' the less distance upper arms 80A''' and 80B''' and bottom members 34A''' and 34B''' extend towards front bath wall 24C''' (not shown), thus providing greater room for the bather.

[0041] A list of component parts from the alternative composite embodiment G that are similar to those found in the alternative composite embodiments A-C, but subject to slight modification due to the inherent differences in design, include, but are not limited to: upper wall rod 82''', rotatable member 32''', lower seat rod 86''', bottom member 34A''', bottom

member 34B''', upper arm 80A''', upper arm 80B''', bath 20''', bath wall 24A''', bath wall 24B''', bath wall 24C'' (not shown), bath wall 24D''', bath bottom 24E''', seat assembly 22''', seat 22A''', and seat back 22B'''.

USE AND OPERATION OF ALTERNATIVE COMPOSITE EMBODIMENT G:

[0042] The operation of alternative composite embodiment G is similar to that of the alternative composite embodiment A. However, because both the angle of the back side wall 24A''' is steeper, and the bath recess 434 allows arms 80A''', 80B''', 34A''' and 34B''' to be mounted within back recess 434, when seat assembly 22''' is in its lowered position the seat assembly 22''' is located at a distance that is further away from front wall 24C''' than seat assembly 22 is from front wall 24C in the alternative composite embodiment A.

ALTERNATIVE RETROFIT EMBODIMENTS D AND H:

[0043] Alternative retrofit embodiments D and H are shown in FIGS. 13-25 and 36-43, respectively. Specifically, the alternative straight up retrofit embodiment D is shown in FIGS. 13-25 and the alternative laterally offset retrofit embodiment H, (whose figure numbers are indirectly referred to in this section in the parenthetical), is shown in FIGS. 36-43. The alternative retrofit embodiments D and H comprise: a frame, generally indicated at 300 (300''), a seat assembly, generally indicated at 22', guiding assembly, generally indicated at 26' (26''), lifting device, generally indicated at 28', and lifting power system, generally indicated at 30'. The alternative retrofit embodiments D and H are intended to be compatible with a majority of standard baths, old or new. In addition, it is contemplated that the proposed system could be subsequently removed from such baths while leaving them in substantially the same condition as they were in pre-installation.

[0044] Frame 300 (300''), best shown in FIGS. 13, 15 and 19, has two side members 346A (346A'') and 346B (346B''), two bottom members 348A (348A'') and 348B (348B'') and two cross-members 342 and 344. The two cross-members 342 and 344 have a length that allows frame 300 (300'') to fit within standard bath widths, and to provide sufficient stability during high torque activities, such as shown in FIG. 37, where seat assembly 22' is occupied with a bather and is swiveled to extend over the side of bath 20'. Other retrofit embodiments may use, for example, a single center placed frame side and bottom members while extending the cross-members towards the side of the bath, rather than between such frame side members.

[0045] Side members 346A (346A") and 346B (346B"), as shown in FIGS. 13, 15 and 19, are fixedly attached to bottom members 348A (348A") and 348B (348B") such that the side members 346A (346A") and 346B (346B") rest substantially parallel to the back wall 24A' of a standard bath and the bottom members rest substantially parallel to the bottom 24E' of the bath 20' (i.e., 90° from vertical). In the alternative retrofit embodiments D and H shown in such Figures, the angle of the back wall 24A' is 30° from the vertical, and as such, the side members 346A (346A") and 346B (346B") are attached at a 120° angle from the bottom members 348A (348A") and 348B (348B"). At such an angle, the alternative retrofit embodiments D and H are operable for any bath with a back angle steeper than 30°, as the side members 346A (346A") and 346B (346B"), need not rest parallel with the back wall 24A' of the bath 20' as long as the top of the side members 346A (346A") and 346B (346B") can be connected to the top of the back bath wall 24A'. It is preferable to use a steeper angle in the design, as the farther back the frame 300 (300") rests, the farther back the seat assembly 22' also rests.

[0046] The cross-members 342 and 344, as shown best in FIGS. 15 and 19, are attached to the upper ends of the side members 346A (346A") and 346B (346B") and at the far ends of bottom members 348A (348A") and 348B (348B"). Other embodiments may place such cross-members elsewhere, or utilize a smaller or greater number of cross-members, or have no cross-members at all, for example, where the upper wall rod 82' (82"), rotatable rod 32' (32") and/or lower power lifting rod 352 (352") would provide the rigidity otherwise provided by the cross-members 342 and 344. Attached to the bottom of bottom members 348A (348A") and 348B (348B"), as shown in FIGS. 14, 17 and 38, are rubber feet 350A and 350B.

[0047] Securing frame 300 (300") to bath 20', as best shown in FIGS. 13, 15 and 19, is accomplished by attaching the frame 300 (300") to the top of back bath wall 24A' via back brackets 390A and 390B, bolts 392A, 392B, 396A, 396B, 400A and 400B, and nuts 394A, 394B, 398A (398A not shown), 398B, 402A and 402B. Specifically, bolts 396A, 396B, 400A and 400B, along with nuts 398A (not shown), 398B, 402A and 402B, secure brackets back 390A and 390B to the frame 300 (300"), and bolts 392A and 392B along with nuts 394A and 394B secure the same brackets to the back of the bath. Preferably, nuts 394A and 394B are expanding anchor "butterfly" nuts or blind fasteners. As explained below in detail, FIG. 45 illustrates a blind fastener, generally indicated at 602, using a threaded bolt 602A with a holding portion 602B. Examples of other blind fasteners are proposed in U.S. application Serial No. 10/696,332, filed October 29, 2003, which is a continuation-in-part of U.S. application Serial No. 10/418,448, filed April 17, 2003. The entirety of each of these

applications are hereby incorporated herein by reference. Both of these applications are assigned to assignee of the present invention. Although the alternative straight up retrofit embodiment D uses the described brackets, bolts and nuts, at a location at the top of the back of the bath, it is contemplated that other embodiments may utilize other appropriate attachment locations and means, including the use of suction cups, and the use of the suction cups along the frame.

[0048] Seat assembly 22', preferably fabricated from a non-corrosive material such as plastic or fiberglass, can be seen in FIGS. 13-14, 17-19, 27 and 37-38. As best shown in FIGS. 13-14, 16-19, 35, 37 and 38, seat assembly 22' includes a seat back 22B' and a seat 22A'. The seat back 22B' and seat 22A' are attached together, respectively, via seat back support 308 and seat base 306 which are rigidly connected to one another as shown in FIGS. 13, 14 and 17-19.

[0049] Seat back support 308, as best shown in FIGS. 14, 19 and 38, is connected to seat back 22B' via seat back brackets 312A and 312B, and pivot bar 314. Pivot bar 314 passes through the top of seat back support 308 and extends either side thereof. Such extensions are pivotally connected to seat back brackets 312A and 312B, such that seat back 22B' may pivot forward and backward about the connection. Tension coil spring 316 constantly provides a force about pivot bar 314 urging the seat back 22B' towards the vertical, as seen in FIG. 14. The ability of seat back 22B' to move away from the vertical towards the horizontal, when a force is applied to the top of seat back 22B', allows a bather to move his nor her upper body lower into the water and allows them also to easily slide his or her body forward towards the front of seat 22A', allowing a bather to submerge more of their body into the water.

[0050] Seat base 306, as best shown in FIGS. 16-18, is pivotally connected to seat anchor plate 304 via pivot pins 318A and 318B, which in turn, is rotatably connected to seat bracket 46 (46") via rotation assembly 40'. The seat base 306 is formed in a "U" shape with seat base arms 302A and 302B pointing towards the front of bath 20'. At the ends of the seat base arms 302A and 302B are holes through which pivot pins 318A and 318B are located. Seat base 306 and seat assembly 22', as shown in FIG. 17, are in the operating position for holding a bather. As shown, seat base 306 is substantially parallel to the bottom of the bath 20'. When the seat assembly 22' is in the access position for cleaning, as shown in FIG. 18, seat base 306 is rotated about pivot pins 318A and 318B exposing the mechanisms located beneath seat 22A', as shown in FIG. 19.

[0051] Arm rest 320, as shown in FIGS. 13, 14, 16-19 and 37, is made up of an arm rest bracket 322, an arm rest arm 324, and an arm rest cushion 326. As shown in FIGS. 16 and

19, the arm rest bracket 322 is formed in an "L" shape and is connected to seat base 306 underneath seat 22A'. The arm rest bracket 322 extends around and above seat 22A'. Connected at or near the top of arm rest bracket 322 is arm rest arm 324 which extends perpendicular to arm rest bracket 322 and substantially parallel with seat 22A'. The shape of the arm rest 320 components shown in the FIGS. is illustrative and exemplary only, and any desired shape can be used. In addition, the arm rest 320 can be of any desired size. Although only a single arm rest 320 is shown in the FIGS., two arm rests 320 can be used, one on each side of seat assembly 22′. If two arm rests 320 are provided, they can be of different sizes.

[0052] In FIGS. 38 and 39, arm rest 320' has features not shown in the other Figures. Arm rest arm 324' and arm rest bracket 322' are shown where the arm rest arm 324' is able to extend outward along its length away from seat back 22B'. The arm rest bracket 322' is different in that it includes a backwards "7" shape. This shape allows for a longer arm cushion 326' so that telescoping arm rest arm 324' can extend further out. Arm rest arm 324' is shown attached to angled arm rest bracket 322'. Arm rest arm 324' is shown having the additional components of an outer member 446 with tracks 452A and 452B, an inner member 448, and the telescope pins 450A and 450B. Telescope pins 450A and 450B are attached to the outer sides of inner member 448 and located in a position so that the pins extend through tracks 452A and 452B of outer member 446 allowing outer member 446 to slide about inner member 448, but not allowing the outer member 446 to slide so far as to extend beyond the length of inner member 448. The retraction of outer member 446 to its retracted position, as shown in bold in FIG. 38, is blocked when either telescope pins 450A and 450B contact the end of tracks 452A and 452B near seat back 22B', or when outer member 446 contacts the portion of arm rest bracket 322' that attaches to arm rest arm 324'. The shape of the arm rest 320' components shown in the FIGS. is illustrative and exemplary only, and any desired shape can be used. In addition, the arm rest 320' can be of any desired size. Although only a single arm rest 320′ is shown in the FIGS, if desired, two arm rests 320′ can be provided. If two arm rests 320′ are provided, they can be of different sizes. Any combination of arm rests 320 and 320' can be provided as desired, including one each of arm rests 320 and 320′ attached to each side of seat assembly 22′, which may be of different sizes if desired.

[0053] Seat anchor plate 304, best shown in FIG. 16, like seat base 306 also has holes in the ends of its arms 304A and 304B and which the same pivot pins 318A and 318B are located there through. As such, the pivot pins 318A and 318B connect the seat base 306 to the seat anchor plate 304 such that when the seat is in its operating position, as shown in FIG. 17, the seat base arms 302A and 302B, as best seen in FIG. 16, are parallel to, and positioned

outside and adjacent to the seat anchor plate arms 304A and 304B. Further, the pivot pins 318A and 318B allow the seat to move from the position, shown in FIG. 17, to the access position, shown in FIG. 18, which allows a user to have open access to the components underneath the seat assembly 22' as well as access to the bottom of the seat assembly 22' and the components attached thereto, as best shown in FIG. 19. Therefore, seat anchor plate 304 is indirectly connected to seat assembly 22'.

[0054] Seat rotation assembly, generally indicated at 40', and as best shown in FIG. 19, is located under seat anchor plate 304. As best shown in FIGS. 20 and 21, seat base 306 is attached to rotor 48' of rotation assembly 40' by means of stainless steel bolts 56'. Rotor 48' rotates about post 50' within housing 44' of rotation assembly 40' and is secured about post 50' via the upper lip 331 of post 50'. Post 50' is secured to seat bracket 46 within the center of housing 44' via bolts 328. Rotor 48' rotates within housing 44' contacting lower bearings 52', upper bearings 332, as well as seals (o-rings) 58' and 330. Lower bearings 52' are maintained at a constant distance from one another by spacer ring 335. Similarly, upper bearings 332 are maintained at a constant distance from one another by spacer ring 333. Both spacer rings 333 and 335 are of a flat ring design. Housing 44' is preferably integral with cantilevered seat bracket 46, which is in turn attached to guiding assembly 26' (26").

[0055] Locking pin, generally indicated at 60', and as best shown in FIGS. 17-21, along with pin holes/notches 62' and 64' in rotation assembly 40', are used to lock seat assembly 22' into two predetermined positions. Locking pin 60' has a pin arm 334, engagement pin 338, rotation block 336 and pivot pin 340. As best shown in FIG. 19, pivot pin 340 extends between seat anchor plate arms 304A and 304B and through rotation block 336 located between the two arms. Pin arm 334 is attached to the forward portion of rotation block 336 while the engagement pin 338 is attached to the back portion. As shown in FIGS. 17 and 19, pin arm 334 extends to the side of the seat 22A' near bath wall 24D'. Pin arm 334 overbalances locking pin 60' such that engagement pin 338 is urged into contact with the cylindrical exterior 40A' of rotation assembly 40'. Therefore, without the application of an outside force, the engagement pin 338 will engage pin holes/notches 62' or 64' as seat rotation assembly 40' is rotated, and once engaged with the appropriate pin hole/notch 62' or 64', engagement pin 338 will remain engaged until an outside force is applied to disengage the engagement pin 338.

[0056] Guiding assembly 26', of the alternative straight up retrofit embodiment D, is similar to the guiding assembly 26 of alternative composite embodiment A. However, where the alternative composite embodiment A discusses applying a torque about rotatable member

32 resulting in the lifting of seat assembly 22, the alternative straight up retrofit embodiment D uses actuators 28A and 28B attached between the second set of arms 80A' and 80B' and the frame 300. Further, and as best shown in FIGS. 13-15, 17-18 and 27-29, upper arms 80A' and 80B' and lower arms 34A' and 34B' may be attached to the frame 300, or to the back wall of the bath 24A', (i.e. for composite embodiments not using a frame), and/or such attachments may be so spaced, such that when seat assembly 22' is in its raised position the upper and lower arms 80A', 80B', 34A' and 34B' are substantially closer to horizontal than when seat assembly 22' is in its lowered position, and as a result, seat assembly 22' is positioned further away from back bath wall 24A', and closer to the middle of the length of the bath 20' when the seat is in its raised position than when it is in its lowered position. An advantage of this operation is that in the lowered position the bather, along with seat assembly 22', is positioned at or near the back of the bath 20' allowing for maximum leg room, and when in the raised position the bather, along with seat assembly 22', is further from the back bath wall 24A' and closer to the middle of the bath 20' allowing for ingress and egress to the seat at a location less likely obstructed by bathroom fixtures such as sinks, cabinets, toilets or the like.

[0057] Also, like the alternative composite embodiment A, as shown in FIG. 36-38, the alternative laterally offset retrofit embodiment H may have its first and second set of arms, 34A", 34B", 80A" and 80B", mounted at an angle Ø with respect to the bath bottom 24E', such that the guiding assembly 26" guides seat assembly 22' from a lowered position, at or near the longitudinal center of the bath, to a raised position, where seat assembly 22' is laterally offset near side wall 24D'. As shown in FIG. 37, angle Ø is 15°, which allows seat assembly 22', in the raised position, to be within four inches or less of the edge of the bath and provides a significant increase in convenience for getting in and out of bath 20'. It is contemplated that the adjacent bathroom wall may be located on the opposite side of the bath, (i.e., faucet and drain at other end of bath), and angle Ø reversed to allow seat assembly 22' to travel towards the entry side of bath 20', as seat assembly 22' moves from the lowered position to the raised position. With the guiding mechanism mounted at an angle on the alternative laterally offset retrofit embodiment H the components of the bath lifting system may require slight modifications, for example: guiding assembly arms 34A", 34B", 80A" and 80B", may be modified to accommodate angled rods 32", 82", 84", 86", 310" and 352"; frame 300" may be modified such that side members 346A" and 346B" and extension bottom members 348A" and 348B" can accommodate the angled rods 32", 82" and 352"; seat bracket 46" may be modified accordingly; and spacers 354", 356", 358", 364", 362" and 360" may be modified to be longer or shorter, or eliminated altogether (see FIG. 37 where spacer 360',

otherwise visible about lower lifting rod 352 in FIG. 19, has been eliminated as the connection to frame side 346A" provides the stability otherwise required by spacer 360'), to accommodate the new location of lifting actuators 28A and 28B. In addition, other parts and components may be added to accommodate the angled position of the guiding assembly 26" including: one or more stabilizer assembly 404 components for added stability as well as additional spacers 440, 442 and 444, as shown in FIGS. 36 and 37, for stabilizing guiding assembly 26" about rods 82" and 84". Yet other parts and components may be modified or added to accommodate the angular positioning of guiding assembly 26" without diverging from the spirit of the invention.

[0058] Further, and like the same angled mounting of guiding assembly 26 of the alternative composite embodiment A, when the guiding system 26" is mounted at an angle in the alternative laterally offset retrofit embodiment H, any rearward extension of the top of seat back 22B' can be made longer. This is because when rotated to an angle approaching 90° to that of seat assembly 22"s orientation when it is in its lowered position, seat back 22B' is farther from side wall 24B', and any room wall adjacent thereto, and thus may extend further rearward without contacting the surface of any such adjacent room wall. Such an angled mounting, i.e., alternative laterally offset retrofit embodiment H, not only provides an advantage of easier ingress and egress to seat assembly 22', but also allows a longer rearward extension of seat back 22B' which, when seat assembly 22' is in its lowered position, provides greater coverage over the guiding assembly 26" and lifting device 28', thus reducing the visibility to such mechanical items.

[0059] In the alternative retrofit embodiments D and H, a lifting device, generally indicated at 28', and as best shown in FIGS. 15, 19 and 36, is a pair of high pressure hydraulic actuators mounted between the frame 300 (300") and the guiding assembly 26' (26"). Spanning between the approximate center of the upper rod arms 80A' (80A") and 80B' (80B") of the guiding assembly is upper lifting rod 310 (310"). Attached between the two bottom members 348A (348A") and 348B (348B") of frame 300 (300") is lower lifting rod 352 (352"). Connected between lower lifting rod 352 and upper lifting rod 310 are the two lifting actuators 28A and 28B. In the alternative straight up retrofit embodiment D these lifting actuators 28A and 28B are held in position along the length of lifting rods 352 and 310 by cylindrical spacers. Spacers 354, 356 and 358 are located about upper lifting rod 310 where spacer 354 and 358 are of approximate equal length and located between upper arms 80A' and 80B' and lifting actuators 28A and 28B, and spacer 356 is located between the two lifting actuators. Spacers 360, 362 and 364 are located about lower lifting rod 352 where spacer 360

and 364 are of approximate equal length and are located between bottom members 348A and 348B and lifting actuators 28A and 28B, and spacer 362 is located between the two lifting actuators. In the alternative retrofit embodiments D and H, as shown best in FIGS. 15 and 19, high pressure pipe 388 communicates hydraulic pressure is provided to the two lifting actuators 28A and 28B. High pressure pipe 388 is diverted into two control pipe paths 388A and 388B at "T" connector 366. As best shown in FIGS. 15 and 17, control pipe paths 388A and 388B are connected through lifting actuator inlets 368A and 368B (not shown) into the lifting actuators 28A and 28B. Other embodiments may use a different number of actuators. Also, other embodiments may use a larger or smaller number of spacers.

[0060] Lifting power system 30' is best shown in FIGS. 13 and 25. In the alternative retrofit embodiments D and H, the lifting power system 30' has the following three components: a fluid control system, generally indicated at 94', a drive system, generally indicated at 96', and a hydraulic pressure multiplier system, generally indicated at 432. The fluid control system 94' controls the in-flow and the out-flow of fluid, such as liquid, into the drive system 96' and, therefore, controls the raising and lowering of the seat assembly 22'. The drive system 96' transforms the relatively low fluid pressure into a mechanical linear force. The hydraulic pressure multiplier system 432 transforms the mechanical linear force into a relatively higher fluid pressure and directs the higher hydraulic pressure into high pressure pipe 388. In the alternative retrofit embodiments D and H, the lifting power system 30' is located out of view, behind a bathroom wall adjacent the bath 20'. Other embodiments may place the lifting power system above the bathroom ceiling, or, if necessary, even expose such a system in the bathroom itself. Other alternative embodiments may use other forms of lifting power systems that provide pressurized fluid through high pressure pipe 388, for example, an electric pump. It is also contemplated that the lifting power system 30' may be used in conjunction with a constant pressure pump for the purpose of providing adequate pressure for those instances where the low fluid pressure is below the minimum pressure required for its operation. For example, it is contemplated that the lifting power system requires 40 PSI to function normally; if the water pressure available is below such PSI, a constant pressure pump can be used to provide adequate pressure for the normal operation of lifting power system 30'.

[0061] As best shown in FIG. 13 and 25, the fluid control system 94' of the alternative retrofit embodiments D and H, is made up of the following components: a feeder pipe 100', a control valve 102', a discharge pipe 104', a control knob 106', a needle valve 180' (FIG. 25), a needle valve adjustment mechanism 182' (FIG. 25), and a high pressure pipe 388 between

needle valve 180' and lifting actuator inlets 368A and 368B. In the alternative retrofit embodiments D and H, the fluid in the fluid control system 94' contains water under standard tap water pressure. Further, it is noted that standard water pressure is typically between 40 and 70 PSI. However, it is contemplated that the fluid could be pressurized by other means, such as a pump. Other alternative embodiments may use other forms of fluid control systems that control the flow of fluid into and out of fluid control system 94' or the drive system 96'. Also, it is contemplated that other embodiments may use a fluid control system 94' that contain other fluids other than water, such as gas.

[0062] As shown in FIG. 13, control valve 102' controls the flow of fluid between feeder pipe 100' and high pressure pipe 388. Control knob 106' operates control valve 102' to allow fluid to enter into, and exit from, drive system 96' which, in turn, raises and lowers seat assembly 22'. Control pipe 108' communicates fluid into and out of drive system 96'. Discharge pipe 104' empties fluid from drive system 96' into bath overflow drain 370 by moving the control knob 106' so the control valve 102' is in the discharge position.

[0063] As best shown in FIGS. 13 and 25, the drive system 96' of the alternative retrofit embodiments D and H comprises a primary chamber housing 111', a primary chamber 112', a connecting piston rod 114', a primary piston head 116', and primary piston head directional seals 124' and 372. Primary chamber housing 111' defines primary chamber 112'. Both primary chamber 112' and primary piston head 116' are approximately 6 inches in diameter. The primary chamber 112' is dynamically divided between the rod side and the non-rod side. The non-rod side of primary chamber 112' contains varying volumes of liquid and is in fluid communication with control pipe 108'. The rod side of the primary chamber 112' contains a varying amount of gas, under a varying amount of pressure. As, primary chamber 112' is filled and emptied of fluid from and to the fluid control system 94', primary piston head 116' travels within primary chamber 112'. Primary piston head 116' and primary piston head directional seal 372 provide a seal such that the liquid cannot pass into the gas filled portion of primary chamber 112'. Initially, the rod side of primary chamber 112' contains a gas pressurized to 10 PSI, as measured by gauge 374. This 10 PSI of pressure provides enough force to overcome overall system frictional forces, and other inherent forces, to urge primary piston head 116' towards the non-rod side of the primary chamber 112', allowing seat assembly 22' to be lowered into the bath. The gas filled portion of primary chamber 112' is in fluid communication with valve 385. Valve 385 is similar to an inner tube valve. Using valve 385, air can be pumped into, or let out of the gas filled portion of primary chamber 112'. Thus, the valve 385 can be used to raise or lower the pressure in the chamber 112' to its

recommended at rest pressure of 10 PSI. An overpressure condition might occur, where the valve 385 may need to be used to remove some of the gas, where there is an over pumping condition or where the cause is related to heat influence. Primary piston head 116' and primary piston head directional seal 124' provide a seal such that the gas cannot pass into the liquid filled portion of primary chamber 112'. Shared piston rod 114' is connected to primary piston head 116' and moves linearly with the movement of primary piston head 116'. In the alternative straight up retrofit embodiment D, as best shown in FIG. 13, the maximum travel distance C of primary piston head 116' is less than the entire length of primary chamber housing 111', and in the alternative straight up retrofit embodiment H, is 12 inches. At distance C it is contemplated that the amount of fluid to fill primary chamber 112' is approximately 6 quarts. This design maintains a minimum amount of pressurized gas defined by the volume represented by C'. Other alternative embodiments are contemplated that may use other forms of drive systems to transform fluid pressure into mechanical energy.

[0064] Returning to FIG. 25, the hydraulic pressure multiplier system 432 of the alternative retrofit embodiments D and H comprise a secondary chamber housing 376, a secondary chamber 378, shared piston rod 114', a secondary piston head 380, and secondary piston head directional seals 382 and 384. Secondary chamber housing 376 defines secondary chamber 378. Both secondary chamber 378 and secondary piston head 380 are approximately 1.5 inches in diameter. The secondary chamber 378 is dynamically divided between the rod side and the non-rod side. The non-rod side of secondary chamber 378 contains varying volumes of liquid. The rod side of the secondary chamber 378 is in fluid connection with the rod side of primary chamber 112', and as such, contains the same varying amounts of gas pressure as in the primary chamber 112'. Secondary piston head 380 and secondary piston head directional seal 384 provide a seal such that the liquid cannot pass into the gas filled portion of secondary chamber 378. Secondary piston head 380 and secondary piston head directional seal 382 provide a seal such that the gas cannot pass into the liquid filled portion of secondary chamber 378. Shared piston rod 114' is connected to secondary piston head 380 and moves linearly with the movement of secondary piston head 380, and in the alternative retrofit embodiments D and H, is 12 inches. In the alternative retrofit embodiments D and H, as best shown in FIG. 13, the maximum travel distance D of secondary piston head 380 is the same maximum travel distance C of primary piston head 116'. The design of the hydraulic pressure multiplier system 432 described immediately above, could be modified by reducing its dimensions, i.e, by reducing the diameter of the primary chamber 112', and reducing the amount of water needed to operate the system. It is

contemplated that such a design would be more expensive, but as designed above, and explained below in greater detail, the lifting force "L" at the zero extension "E" is the smallest, but has enough lift to raise a heavy person. And even after a short lifting distance, i.e., where "E" is approximately 2 inches, the force "L" is almost 75% larger than is necessary, and therefore represents a wasted use of tap water. A reduced diameter primary chamber 112' could reduce the above design's use of 6 gallons of water to a lesser amount of 4 gallons. Other alternative embodiments are contemplated that may use other forms of drive systems to transform a lower fluid pressure into a higher fluid pressure.

[0065] The alternative lifting power system 30" illustrated in FIGS. 40-43 uses two of the same components as the lifting power system 30': the fluid control system 94', as shown in FIG. 13, and the hydraulic pressure multiplier system 432, as shown in FIGS. 13 and 25. However, a third component, preferred drive system 96" is used in place of drive system 96'. Like the drive system 96', shown in FIGS. 13 and 25, the preferred drive system 96" transforms the relatively low fluid pressure into a mechanical linear force. However, unlike drive system 96', preferred drive system 96" uses a smaller diameter primary piston head 116" in conjunction with a larger surrounding cylinder bushing 454.

[0066] Specifically, primary piston head 116" has a diameter of four inches. This smaller diameter allows it to fit within the inner walls 456 of primary cylinder bushing 454. Cylinder bushing 454 includes a cylinder bushing end 458, a cylinder bushing end 460, a plurality of spacer extensions 462, outer head extensions 464, and an inner head extension lip 466. As shown in FIGS. 40-42, primary cylinder bushing 454 contacts primary chamber housing 111' with its spacer extensions 462 near its end 458, and contacts primary chamber housing 111' with its outer head extensions 464 at its other end 460. The intermittent radial spaced placement of these spacer extensions 462 allow for the fluid communication of the gas between the bushing void 457 and the primary chamber 112'. The outer head extensions 464 further include cylinder bushing directional seals 468 and 470. Cylinder bushing directional seal 470 provides a seal such that the liquid cannot pass into the gas filled portion of primary chamber 112'. Cylinder bushing directional seal 468 provides a seal such that the gas cannot pass into the liquid filled portion of primary chamber 112'.

[0067] Fully retracted, the end 460 of primary cylinder bushing 454 is at or near the right of primary chamber 112', as viewed and best shown in FIG. 40. When fully extended, the end 458 of primary cylinder bushing 454 is at or near the left of primary chamber 112' and the end 460 of primary cylinder bushing 454 is at a distance "J" in the primary chamber 112', as best shown in FIGS. 41 and 42. When the primary piston head 116" is in its fully extended

position, as shown in FIG. 42, the primary piston head 116" is positioned along the inside wall 456 of primary cylinder bushing 454 at a distance "C" in the primary chamber 112'.

[0068] Primary piston head 116" has two seals 124" and 372' that perform similarly to seals 124' and 372, respectively, of primary piston head 116'. However, unlike primary piston head 116', piston head 116" travels within the inside wall 456 of primary cylinder bushing 454 for distance "J," a sub-length of distance "C." The primary cylinder bushing 454 travels as one with primary piston head 116" such that the two seals 124" and 372' remain in static contact with inside wall 456. As such, these seals experience less wear and tear than their 124' and 372 counterparts, which experience sliding contact for the entire distance "C" along primary chamber housing 111'.

[0069] Further, and unlike the embodiment depicted in FIGS. 13 and 25, the embodiment shown in FIGS. 40-43 uses a primary cylinder bushing 454 which reduces the volume of liquid necessary to fully retract primary piston head 116" from 6 quarts to 4 quarts. Thus, less water is required to move the seat assembly 22 from its lowered position to its extended position. Also, unlike the embodiment depicted in FIGS. 13 and 25, where a force "L" at a distance "E" of two inches, is of a force that is almost 75% larger than necessary (i.e., 1312.5 lbs = 1.75 * 750 lbs), the embodiment of FIGS. 40-42 results in the reduction of the force "L" at a distance "E" of about two inches to an amount of approximately 850 lbs.

USE AND OPERATION OF ALTERNATIVE RETROFIT EMBODIMENTS

[0070] A typical bather, being wheelchair assisted, would typically leave the bath system with seat assembly 22' in its lowered position, as shown in FIG. 13. To transfer to the bath 20', bather wheels his or her chair along side of bath 20'. The operator of the bath system then uses control knob 106' to initiate the flow of water from feeder pipe 100' through control pipe 108' into primary chamber 112'. As water fills chamber 112', the water pressure forces piston head 116' along primary chamber 112' towards the rod-end of primary cylinder 112'.

[0071] When using the drive system 96' as shown in FIGS. 13 and 25, as primary piston head 116' travels along primary chamber 112', piston rod 114' pushes secondary piston head 380 in secondary chamber 378. Since the area of the primary piston head 116' is greater than the surface area of secondary piston head 380, any PSI applied to the primary piston head 116' will result in a larger applied PSI from secondary piston head 380, see FIG. 22. This PSI multiplying mechanism is an effective way of increasing PSI levels such that small high pressure piston mechanisms, such as high pressure lifting actuators 28A and 28B, can be

disposed entirely in the frame of the retrofit embodiment behind seat assembly 22'. The movement of primary piston head 116' towards the rod-end portion of primary cylinder 112' causes shared piston rod 114' to move in the same direction along with secondary piston head 380, which for secondary piston head 380, is away from the rod-end portion of secondary cylinder 378. It should be noted that as primary piston head 116' moves in the rod-end direction, the pressurized gas becomes further pressurized until the maximum movement C (FIG. 13) is achieved. It is contemplated that the minimum and maximum pressure of such gas is approximately 10 PSI and 30 PSI, respectively, however, this build-up of pressure is essentially inconsequential while seat assembly 22' is occupied with a bather, as the force supplied by such gas pressure is small in comparison to the additional pressure introduced by the weight of the bather on seat assembly 22'. With the movement the primary piston head 116', toward the rod-end portion of primary cylinder 112', secondary piston head 380 forces water through high pressure pipe 388. As shown in FIGS. 14, 15 and 17, the pressurized fluid travels down high pressure pipe 388 and into the lifting actuators 28A and 28B. Being under high pressure, a relatively smaller volume of liquid is necessary to effectuate the lifting force required to lift a bather. As the fluid fills the two actuators 28A and 28B, their respective lifting piston rods 386A and 386B (FIG. 19) expand outwardly, spacing apart upper lifting rod 310 (310") and lower lifting rod 352 (352") (FIG. 17) resulting in the upward movement of guiding mechanism 26' and, therefore, seat assembly 22' from a location near the back and at the bottom of bath 20', to a location away from the location near the back and slightly above the top of the bath 20'.

[0072] However, when using the drive system 96", as shown in FIGS. 40-42, where both primary piston head 116" and a primary cylinder bushing 454 are used, a slightly different operation occurs. Here, from an initial position where both primary piston head 116" and primary cylinder bushing 454 are positioned at the right of primary chamber 112', as viewed and shown in FIG. 40, primary piston head 116" travels in unison with primary cylinder bushing 454 until a distance "J" is achieved, as shown in FIG. 41. At this point the bottom of cylinder bushing 454 contacts the left of primary chamber 112' blocking further leftward movement. Although the cylinder bushing 454 is blocked, piston head 116" continues to move. Piston head 116" then begins to move relative to cylinder bushing 454, and in so doing, is guided by the walls 456 of cylinder bushing 454.

[0073] Here, like the embodiment in FIGS. 13 and 25, piston rod 114' moves with piston head 116", and pushes secondary piston head 380 in secondary chamber 378. Since the surface area of primary piston head 116" alone, much less the area of primary piston head

116" plus end 460 of primary cylinder bushing 454 together, are greater than the surface area of secondary piston head 380, any PSI applied to the primary piston head 116" will result in a larger applied PSI from secondary piston head 380. The resulting force differences achieved between the two embodiments, i.e., the embodiments depicted in FIGS. 13 and 25 as opposed to those depicted in FIGS. 40-43, is evident when comparing FIG. 24 with FIG. 43, respectively. In FIG. 43 a drastic drop is shown in the lifting force "L" when "E" is just short of two inches. Also, the forces are also shown to be different where after reaching "E" of two inches, the maximum "L" attained is less than 1000 lbs and reaches a further low at "E" equal to six inches. In contrast, in FIG. 24 the lifting force "L" continues to rise after reaching an "E" value of two inches until the maximum "L" reaches approximately 1420 lbs and never falls below a level of approximately 1100 lbs. In sum, the embodiment using drive system 96" uses less water than those embodiments using drive system 96' but maintains a force above the minimum required.

[0074] In its fully raised position, seat assembly 22' is at or beyond the top of the side wall 24D' of bath 20', so that bather can transfer to seat assembly 22'. Once above the side wall 24D' of bath 20', the seat can be rotated 90° so that locking pin 60' is engaged with pin hole/notch 64'. In the alternative laterally offset retrofit embodiment H, this 90° rotation results in seat 22A' extending over side wall 24D' as shown in phantom view in FIGS. 3 and 37, while in the alternative straight up retrofit embodiment D, the 90° rotation leaves seat 22A' short of extending over such side wall. As shown in Fig. 16, and as intended for use in both alternative laterally offset retrofit embodiments D and H, seat assembly 22' is attached to rotation assembly 40' such that seat assembly 22''s center of gravity G is forward, and therefore eccentric, from the rotation axis R of rotation assembly 40'. This design has the front of seat 22A' following an arc that is otherwise further from the rotation axis R of rotation assembly 40' than designs that essentially place the center of gravity G of the seat assembly 22' on top of the rotation axis R of rotation assembly 40'. As shown, the center of gravity G of seat assembly 22' is 3 inches forward the rotation axis R of rotation assembly 40'. If the telescoping arm rest 320' is used (FIG. 38), the outer arm member 446, with attached arm cushion 326', could be pulled out to extend outer arm member 446 beyond the front of the seat. To transfer to seat assembly 22', the bather, if capable, maneuvers his or her wheelchair such that they can slide themselves onto seat assembly 22'. To do so, the bather could use the extended arm member 446 to assist the bather in getting on the seat assembly 22'. Once on seat assembly 22', the bather then can slide the arm cushion 326' and outer arm member 446 back to its retracted position. Then the bather disengages locking pin 60' from

pin hole/notch 64' and rotates the seat while bringing their legs over side wall 24D' and into bath 20'. The bather then engages the locking pin 60' with pin hole/notch 62'.

[0075] As best shown in FIG. 13, and discussed above, once securely in seat assembly 22', control knob 106' is operated to release the water from the primary chamber 112' allowing primary piston head 116' to move in the direction of the non-rod end portion of the primary cylinder 112', causing secondary piston head 380 to move in the direction of the rod end section of secondary chamber 378, and thus lower the bather into bath 20'. The discharged water from primary cylinder 112' travels through control pipe 108' and discharge pipe 104' into bath 20'. During this process, seat assembly 22', guiding assembly 26', lifting device 28', and lifting power system 30', all reverse direction. During the lowering mode, the bather sitting on the seat assembly 22' experiences a constant and smooth descent towards the bath bottom 24E'. Like the alternative composite embodiment A discussed above, the device can be used with a shower and seat assembly 22' can be stopped at any position along its path.

[0076] To allow the bather to exit bath 20', the operator simply follows the steps described above to position the seat for transfer. The operator and bather can be different, or the same person. While exiting bath 20', seat assembly 22' ascends smoothly along a path from the lowered position at or near the bath bottom 24E', to a raised position at or above the side of bath 20'. Once fully raised, the bather reverses his/her earlier movements to transfer back into the wheelchair. Once in the chair, the operator would use control knob 106' to return the seat assembly 22' to its lowered position. To lower the unoccupied seat assembly 22', the operator simply follows the steps described earlier for lowering the seat. However, with the absence of a bather from seat assembly 22', the additional force generated by the pressurized gas behind primary piston head 116', assists the return of seat assembly 22', guiding assembly 26' (26"), lifting device 28', and lifting power system 30' to their respective positions where seat assembly 22' is in its fully lowered position.

[0077] When using the drive system 96' as shown in FIGS. 13 and 25, the resulting forces and pressures acting throughout the alternative straight up retrofit embodiment D are further disclosed in FIGS. 22-24. Specifically, FIG. 22 shows the pressures and forces generated with respect to the movement of the primary or large piston, secondary piston or small cylinder and lifting pistons or lift cylinder. Standard tap water source pressure is shown at about 70 PSI, although it is contemplated that the alternative straight up retrofit embodiment D will work with as little pressure as 40 PSI. The resulting pressure on primary piston head 116' is the sum of the standard source water pressure on the non-rod side of primary chamber 112' less the gas pressure against the rod side of primary chamber 112'. The initial gas

pressure is 10 PSI where the primary piston 116' is fully extended as show in FIG. 13, and the net pressure on piston head 116' is 60 PSI (70 PSI – 10 PSI). When both the primary piston head and secondary piston heads have traveled the full 12 inches of C to the phantom view piston shown in FIG. 13, the gas pressure is at its maximum of 30 PSI. At this position the net pressure on piston head is 40 PSI (70 PSI – 30 PSI). As the primary piston head 116' travels from its initial position to the position at distance C, the net pressure on primary piston 116' falls linearly with the distance traveled. Again, as shown in FIG. 22, the total net range in pressure on the primary piston ranges between 60 PSI and 40 PSI, and the corresponding resultant pressure on secondary piston head 380 ranges approximately between 950 PSI to 630 PSI respectively. Also, the resultant force over this same range from each of the two lifting actuators 28A and 28B is approximately 1650 PSI to 1100 PSI, while the resulting force F along lifting actuator rods 386A and 386B is from approximately 3200 lbs. to 2100 lbs.

[0078] However, when using the drive system 96" as shown in FIGS. 40-42, where both a primary piston head 116" and a primary cylinder bushing 454 are used, some of the resulting forces and pressures vary. In operation, as primary piston head 116" travels the distance "J," essentially the same resulting forces and pressures exist as in drive system 96'. For example, when comparing the charts in FIGS. 43 and 24, the graph of "L," with a vertical component of force and a horizontal component of extension, shows that from an "E" of 0 to an "E" of just short of 2 inches, both graphs are approximately the same. In contrast, as "E" approaches two inches, primary cylinder bushing 454 reaching its maximum extension "J," and at that time the effective surface area of the piston head is reduced from the area of piston head 116" plus the area of the end 460 of primary cylinder bushing 454 to an area of the alternative piston head 116" alone. This change in surface area results in the change in "L" reflected in FIG. 43 where beyond "E" equal to about 2 inches.

[0079] FIG. 23 shows drive system 96' and the net forces along lifting arms 80A and 80B as a result of the forces generated by lifting actuator rods 386A and 386B. Specifically, FIG. 23 shows how the force F, applied along lifting actuator rods 386A and 386B, acts upon lifting arms 80A' and 80B'. Where actuator rods 386A and 386B are extended a distance E = 0 inches, the forces exerted on lifting rod 310 are directed both along lifting arms 80A' and 80B', and along the direction perpendicular, force P, to the lifting arms. Further, a resulting force P/2 is experienced at the seat ends of lifting arms 80A' and 80B' along with a corresponding lifting force L in the vertical direction. As the lifting actuator rods extend towards the 3 inch extension mark, the direction of the perpendicular force P/2 approaches

that of the vertical lifting force, to a point where lifting arms 80A' and 80B' are completely horizontal, and force P/2 is equal to L. An additional graph is supplied in FIG. 24 that shows the change in values of the forces F, P, P/2 and L as the lifting rods 386A and 386B are extended through their operating reach of between 0 and 6 inches.

ALTERNATIVE STRAIGHT UP RETROFIT EMBODIMENT E:

[0080] Turning now to the alternative straight up retrofit embodiment E shown in FIGS. 26-27, the alternative straight up retrofit embodiment E utilizes similar component parts to the alternative straight up retrofit embodiment D, including frame 300, seat assembly 22', guiding assembly 26', lifting device 28', and lifting power system 30'. In addition, alternative straight up retrofit embodiment E includes stabilizer assembly 404 and frame extension 406 for added stability. This embodiment is particularly useful for installation into a bath constructed from such relatively weak materials as acrylic or other weak materials or designs requiring additional support or for such embodiments that use such less intrusive attachment means, for example, suction cups or the use of additional stabilizer arms.

[0081] Frame extension 406 extends along the bottom 24E' of the bath 20'. Frame extension 406 includes extension bottom members 408A and 408B, each fixedly attached to bottom members 348A and 348B respectively, and are attached with the respective fasteners 412A, 414A, 416A (not shown), 418A (not shown) and 412B, 414B, 416B and 418B. The far ends of extension bottom members 408A and 408B are connected by extension cross member 410. Below the corners of such far ends are two rubber feet 420A and 420B.

[0082] Stabilizer assembly 404 utilizes stabilizer arms 404A and 404B on opposite sides of frame 300 and is in contact with the side walls of the bath. This design impedes the horizontal shifting and the torquing movement otherwise present due to the loads placed on the seat, and specifically, to the loads placed on seat assembly 22' when the seat is both laterally offset and rotated over the wall of the bath along with a bather. The stabilizer arms 404A and 404B include elastomer end cushions 406A and 406B, respectively, to provide both a compressible material that would allow the stabilizer arms 404A and 404B to be tightened against the walls of the bath without causing damage, and a surface with a high coefficient of friction to prevent slippage during the application of a torquing force. The stabilizer arms 404A and 404B are connected to either, or both, the frame side members 346A and 346B and the extension bottom members 348A and 348B.

USE AND OPERATION OF ALTERNATIVE STRAIGHT UP RETROFIT EMBODIMENT E:

[0083] The operation of alternative embodiment E is similar to that of the alternative retrofit embodiments D and H. However, forces present in the alternative straight up retrofit embodiment D, otherwise distributed over the limited points of contact of back brackets 390A and 390B and bottom member rubber feet 350A and 350B, would, in alternative straight up retrofit embodiment E, be additionally distributed through stabilizer arms 404A and 404B, as well as frame extension 406. As such, alternative straight up retrofit embodiment E reduces the stress at any one contact point between itself and the bath, by spreading the total force among additional contact points.

ALTERNATIVE STRAIGHT UP RETROFIT EMBODIMENT F:

[0084] Turning now to the alternative straight up retrofit embodiment F shown in FIGS. 28-32, the alternative straight up retrofit embodiment F utilizes similar component parts to the alternative straight up retrofit embodiment D, including frame 300, seat assembly 22', guiding assembly 26', lifting device 28"", and lifting power system 30', but includes an alternative bellows member, generally indicated at 422.

[0085] The bellows member 422 folds into a low profile clearance position (FIG. 28) and expands outwardly in a pyramid shape position, as shown in FIG. 29. The low profile clearance position of deflated bellows member 422 allows the seat assembly 22' to rest close to the bottom 24E' of the bath 20'. The bellows member 422 includes a bellows casing 424, bellows rings 425, a bellows inlet member 426, a bellows bottom 428, and a bellows top 430.

[0086] It is contemplated that bellows casing 424 will be attached underneath seat assembly 22', and more specifically, to cylindrical exterior 40A' (FIG. 20) of rotation assembly 40'. Bellows rings 425 are embedded in casing 424 or are otherwise attached thereto to provide structural integrity including expansion resistance and otherwise direct the bellows expansion upwardly, as shown by the arrow V in FIG. 29, rather than bulging outwardly in a direction generally perpendicular to arrow V. As best shown in FIG. 31, bellows rings 425 are embedded in bellows casing 424 such that as the bellow member expands, the concentric rings 425 begin to unfold such that the casing 424 conforms generally to a stair-step like appearance. When fully deployed or expanded the bellows member 422 takes the pyramid shape, as best shown in FIGS. 29 and 32. Such bellows rings 425 could be made of plastic, metal, fiberglass or any other expansion resistant material that

would tend to direct the bellows expansion along a path between the bellows top 430 and the bellows bottom 428, rather than side-to-side.

[0087] Bellows bottom 428 rests upon bath bottom 24E'. Bellows inlet member 426 allows for fluid to move between the fluid control system 94' (FIG. 13) and bellows member 422. As the bellows member 422 fills with a fluid, it expands and raises seat assembly 22'. With the cantilevered design of the guiding assembly 26', the seat assembly 22' moves along an arcuate path, and as the bellows member 422 is fixedly attached to seat assembly 22', the bellows bottom 428 is pressed against bath bottom 24E, where friction between the bellows bottom 428 and bath bottom 24E' resists movement of such bellows bottom 428 relative to the bath bottom 24E' as the seat is raised and lowered. Here, the bellows casing 424 would expand such that bellows top 430 moves horizontally, and/or forward and/or backward, in relation to bellows bottom 428 and thereby experiences a deformation of its symmetric pyramid shape into an asymmetric form, while efficiently raising seat assembly 22'. Besides the advantages discussed above, the proposed design is advantageous over other bellows design for at least the reason that that the bellows are not attached at the bath bottom, thus allowing for easy cleaning thereunder.

[0088] Other embodiments may attach the bellows in an inverted position. Yet other embodiments may attach the bellows bottom 428 to a plate that is otherwise attached to frame 300. Yet other embodiments may use other guiding assemblies, such as, the use of a simple guide pole or poles that extend from frame 300.

<u>USE AND OPERATION OF ALTERNATIVE STRAIGHT UP RETROFIT EMBODIMENT F:</u>

[0089] The bather mounts and dismounts seat assembly 22' in the same manner as described in the alternative straight up retrofit embodiment D. However, as best shown in FIGS. 13, 28 and 29, to raise seat assembly 22', an operator uses control knob 106' to initiate the flow of fluid, such as water, from feeder pipe 100' through control pipe 108' and ultimately into inlet member 426 of bellows member 422. As water fills bellows member 422, the water pressure expands bellows member 422.

[0090] As bellows member 422 deploys or expands, it pushes away from the bottom of seat assembly 22' against the bath bottom 24E' causing seat assembly 22' to move upward. The guiding assembly 26' guides seat assembly 22' along an arcuate path in a vertical plane along the longitudinal direction to a location where the side of seat assembly 22' is at or

beyond the top of side wall 24D'. In so moving, the set of arms 34A', 34B' and 80A', 80B' of guiding assembly 26' move in unison from a position pointing substantially towards the bottom of bath 20' to a position pointing substantially away from bath wall 24A' of bath 20', and raise seat 22A' above the top of bath 20'. As bellows member 422 is pushed and pulled along the longitudinal direction (or lateral direction if used with laterally offset embodiment), bellows bottom 428 slides along the bath bottom 24E'.

[0091] To lower seat assembly 22', the operator moves control knob 106' to release water from bellows member 422 to discharge pipe 104' into the bath. The weighted seat assembly 22', or, in case a bather is located thereon, the weight of a bather and the seat on bellows member 422 urges the water within bellows member 422 to be ultimately discharged out of inlet member 426 into control pipe 108' and out discharge pipe 104' into the bath overflow drain 370. During the lowering mode, seat assembly 22' experiences a constant and smooth descent towards bath bottom 24E'. It is contemplated that bellows member 422 could be substituted for actuators 28A and 28B in a laterally offset retrofit bath lifting system.

SELF-PRESSURIZED SYSTEM:

[0092] FIG. 44 is a schematic diagram showing a self-pressurized system, which can be used in all embodiments of the invention. The self-pressurized system utilizes many similar component parts as those found in the alternative laterally offset retrofit embodiment H (shown in FIGS. 36-43). However, some component parts that differ significantly include the component parts of the lifting power system 30'". Some component parts that differ less significantly include component parts of lifting device 28'. More specifically, the lifting power system 30'" is different than its 30" counterpart at least in the following areas: the constant pressure generation mechanism 500 is used to transform electrical power into hydraulic pressure, the fluid control system 94"'s remote control system 562 acts as the user control knob 106 and its four-way valve 584 in combination with its valve controller 586 acts as control valve 102. Lifting power device 28""" is different from its 28' counterpart at least because it contains a second high pressure pipe 510 and corresponding control pipe paths 512A and 512B used in the lowering of seat assembly 22. Further, lifting device 28""" also utilizes hydraulic fluid below the piston heads 504A and 504B so that hydraulic pressure can be applied to the underside of such piston heads to cause the piston to travel in the opposite (seat lowering) direction. It is contemplated that other embodiments of the current invention could instead only use hydraulic fluid on the non-piston rod side of the piston head, as is used

in the preferred laterally offset retrofit embodiment. It is also contemplated that the constant pressure generation mechanism 500 could be powered by means other than electricity, for example an internal combustion engine. It is further contemplated that the control valve 102" functionality can be achieved by non-remote and mechanical systems. Further, it is also contemplated that the pressure supplied by constant pressure generation mechanism 500 could be supplied by other sources, such as water tap pressure, stepped-up water tap pressure, or any water pressure means.

[0093] Power system 30''' comprises a constant pressure generation mechanism 500, a fluid control system 94" and an outside power source 502. Further, constant pressure generation mechanism 500 contains a pump device 516, an accumulator 518, a constant pressure switch 520 and a safety valve 522. Pump device 516 comprises a hydraulic pump 524, a pump motor 526, a hydraulic fluid reservoir 528, a pump draw line 530, a pump/accumulator line 532, a pump return line 534, a check valve 536, an accumulator/reservoir line 538, a lifting device return line 540 and motor power lines 542 and 544. Accumulator 518 comprises a housing 546, a bladder 548, hydraulic fluid 550, an air pocket 552, a constant pressure switch/accumulator line 554, a pump/accumulator line 532, an accumulator/reservoir line 538 and a lifting device supply line 556. Further, safety valve 522 is mounted in series in accumulator/reservoir line 538. Constant pressure switch 520 contains a pressure sensor 558 connected to a motor power switch 560 in series in motor power line 544. Pressure sensor 558 is connected to accumulator 518 via pressure switch/accumulator line 554. To provide additional safety mechanisms between power source 502 and bath 20 (not shown in Figure 44), the hydraulic lines of the system can be constructed of a non-electrically conductive high pressure plastic and the hydraulic fluid can have non-electrically conductive properties. Preferably, the second high pressure pipe 510, high pressure pipe 388', are constructed of this non-electrically conductive high pressure plastic while the remainder of the hydraulic lines are constructed with stainless steel, brass, or the like. It is contemplated that the hydraulic fluid used in the self-pressurized system comprises a light oil. Further, it is contemplated that pump device 516 could be achieved through Fenner Fluid Power System, Model No. KP20, supplied by Fenner Fluid Power, which was acquired by SPX Corporation of Rockford, Illinois in 2000. Accumulator 518 could be achieved through Pulseguard Accumulator, Model No. B139x420, supplied by Pulseguard, Inc of Hampstead, North Carolina. Further, constant pressure switch 520 could be achieved by using a Hyvair Pressure Switch model no. HYV PS20-2K, supplied by Hyvair Corporation of Houston, Texas.

[0094] The fluid control system 94" comprises a remote control system 562, a solenoid valve 102" and needle valves 580 and 582. Remote control system 562 contains a remote control receiver 564 and a remote control transmitter 566. The remote control receiver 564 contains radio wave receiver 574, solenoid valve power switch 572 and solenoid valve power lines 576 and 578. Radio wave receiver 574 is connected to solenoid valve power switch 572. The solenoid valve power switch 572 is connected in series with solenoid valve power line 578. The remote control transmitter 566 contains a twelve volt remote battery 570 connected to a radio transmitter 568 with a user button 569. It is contemplated that the remote control transmitter 566 could be sealed within an air/water tight malleable container which would allow the activation of the user button 569 while preventing any fluids or other matter from penetrating the contents of the sealed container. It is also contemplated that such a container could include a sufficient buoyant material, i.e., sufficient air content, foam, etc., to give the remote control transmitter 566 buoyant properties. It is also contemplated that the remote battery 570 would have a working of life of years before needing replacement. Further, solenoid valve 102" contains a four-way valve 584 and a valve controller 586. The four-way valve 584 is connected to the valve controller 586. The valve controller 586 is connected to solenoid valve power lines 576 and 578 and is used to switch the valve between its first and second states. The four-way valve 584 has two states: the first state is where lifting device supply line 556 is in fluid communication with high pressure pipe 388' and lifting device return line 540 is in fluid communication with second high pressure pipe 510, and the second state is where lifting device supply line 556 is in fluid communication with second high pressure pipe 510 and lifting device return line 540 is in fluid communication with high pressure pipe 388'. Here, the first state corresponds to the raising of the seat and the second state corresponds to the lowering of the seat. In addition, needle valve 580 is located within lifting device supply line 556 and needle valve 582 is located within lifting device return line 540 for adjusting the rate of flow in the corresponding lifting device return lines. It is contemplated that the remote control receiver 564 and the remote control transmitter 566 work together at a distance as great as 100 feet. It is further contemplated that a hardwired or manual system could be used in place of the remote control system 562, however, the separation of the high voltage from near proximity to the water within the bath inherent in the remote system is generally believed to be a more desirable design. It is contemplated that control receiver 564 and a remote control transmitter 566 can be achieved by using Westek Model Nos. RFA 114 and RFA 110 respectively, supplied by AmerTac of Monsey, New York. Further, it is contemplated that solenoid valve 102" could be achieved

through Bosch Valve with AC/DC Solenoid and Wiring Box, Model No. 9810231012, supplied by Bosch Rexroth Corporation of Bethlehem, Pennsylvania.

[0095] Lifting device 28''''' contains many similar components of those of lifting device 28', as indicated in FIG. 36 of the alternative laterally offset retrofit embodiment H. Some examples of similar components visible in FIG. 44 include: "T" connector 366', control pipe path 388A', control pipe path 388B', lifting actuator 28A', lifting actuator 28B', lifting piston rod 386A' and lifting piston rod 586B'. Other components relatively dissimilar to those of the components of the alternative laterally offset retrofit embodiment H include: lifting device 28''''''s additional components that allow the inflow and outflow of hydraulic fluid behind the piston heads 504A and 504B. As shown in FIG. 44, piston heads 504A and 504B have, respectively, piston head front surfaces 506A and 506B and piston head rear surfaces 508A and 508B. The piston head seals (not shown) used in this design may be similar to directional seals 124' and 372 described earlier. Other additional components include: a second high pressure pipe 510, a "T" connector 588, and two control pipe paths 512A and 512B. Each of the control pipe paths 512A and 512B communicate fluid to the rod side of the piston in the respective lifting actuators 28A' and 28B'.

USE AND OPERATION OF SELF-PRESSURIZED SYSTEM:

[0096] The operation of the self-pressurized system has many similarities to the operation of the alternative laterally offset retrofit embodiment H as shown in FIGS. 36-43. While the self-pressurized system only aesthetically appears to differ from the alternative laterally offset retrofit embodiment H in that it utilizes a remote control transmitter 566 in place of a mechanical knob or switch, the differences extend beyond that generally viewable by the naked eye. For example, both the power system 30''' and the lifting device 28''''' contain components that are either not present or that are different from those found in the alternative laterally offset retrofit embodiment H.

[0097] It is useful to first describe how the constant pressure generation mechanism 500 works to generate and continually maintain a relatively constant pressure. This constant pressure is ultimately used by fluid control system 94'' and lifting device 28''''' to extend and retract lifting actuators 28A' and 28B'. In the current embodiment the pressure maintained in the accumulator 518 is about 1500 psi and the accumulator 518 has a maximum capacity of 2800 psi. In operation, if pressure sensor 558 detects a pressure below a minimum psi level in pressure switch/accumulator line 554 it signals the motor power switch 560 to close

resulting in the connection of power from the outside power source 502 to the pump motor 526. Being connected to power source 502, pump motor 526 then drives hydraulic pump 524 causing the pumping of hydraulic fluid from hydraulic fluid reservoir 528 through pump draw line 530, through hydraulic pump 524, through pump/accumulator line 532 and into accumulator 518 on the hydraulic fluid 550 side of bladder 548. In contrast, when pressure sensor 558 detects a pressure at or above its maximum normal psi level it signals motor power switch 560 to open, breaking the circuit, and thereby removing power to pump motor 526 and thus stopping the further pressurization within accumulator 518. If the hydraulic pressure from the pump/accumulator line 532 is above a maximum abnormal psi value, the hydraulic pump 524 allows the hydraulic fluid to drain from the pump/accumulator line 532 through the hydraulic pump 524, exiting through the pump return line 534, through the check valve 536, into the hydraulic fluid reservoir 528, until the pressure from the pump/accumulator line 532 falls below such maximum abnormal psi value. As a second safety mechanism, safety valve 522 and accumulator/reservoir line 538 are used to relieve pressure from accumulator 518 when the pressure therein reaches a maximum allowable accumulator psi. If this maximum allowable accumulator psi is reached, safety valve 522 opens and allows hydraulic fluid to drain directly from accumulator 518 through accumulator/reservoir line 538 and safety valve 522 into hydraulic fluid reservoir 528. In sum, constant pressure generation mechanism 500 works independently to maintain pressurized hydraulic fluid to be utilized by the rest of the system via lifting device supply line 556.

[0098] As an illustrative example for this embodiment, the pressure sensor 558 can be set at a pressure between 1400 to 1600 psi, the check valve 536 can be set at a pressure of 2000 psi, and the check safety valve 522 can be set at a pressure of 2600 psi. When the motor power switch 560 is closed, the pump motor 526 and hydraulic pump 524 are operating – thus pressurizing accumulator 518. When the accumulator 518 reaches the set pressure of the pressure sensor 558 (1400 to 1600 psi in this example), the pressure sensor 558 should send a signal to the motor power switch 560, effectively shutting down the pump motor 526 and hydraulic pump 524—thus stopping the accumulation of pressure in the accumulator 518. However, should the pressure sensor 558 fail to activate or should the motor power switch 560 fail to open the circuit, the pump motor 526 will continue to operate hydraulic pump 524, accumulating pressure in the accumulator 518 and associated pump/accumulator line 532. When the check valve 536 senses the pressure at the hydraulic pump 524 reaching a level of 2000 psi, the check valve 536 opens ands drains the pump/accumulator line 532,

protecting the hydraulic pump 526 from its own power and preventing the increase of pressure in accumulator 518. At this point, the hydraulic pump 524 will essentially circulate hydraulic fluid from the hydraulic fluid reservoir 528 up through the draw line 530 and back down through the return line 534 through the check valve 536. Such an operation will continue until the pressure drops below 2000 psi, causing the check valve 536 to close. If the accumulator 518 continues to pressurize despite the aforementioned features, the safety valve 522 will open when the accumulator 518 reaches a pressure of 2600 psi, allowing the pressure in the accumulator 518 to dissipate via accumulator reserve line 538 to the hydraulic fluid reservoir 528.

[0099] With the pressure provided by constant pressure generation mechanism 500, the bather and/or operator is able to control the transfer of hydraulic fluid from constant pressure generation mechanism 500 to lifting device 28""', and ultimately control the raising and lowering of seat assembly 22, by using fluid control system 94". Specifically, using the fluid control system 94", the bather and/or operator transitions the seat assembly 22 between a lowered and a raised position by the press of user button 569 on remote control transmitter 566. When user button 569 is depressed it generates a radio signal that is received by radio wave receiver 574. Once received, the radio wave receiver 574 signals solenoid valve power switch 572 to change its current state (i.e., open or closed). The solenoid valve power switch 572 then either closes or opens, i.e., connects or disconnects solenoid valve power line 578 to outside power source 502, depending on its last state. If the solenoid valve power switch 572 in its open state, i.e., the lowering state, then no power is supplied to valve controller 586, and as a result, the valve controller 586 maintains the four-way valve 584 with its corresponding connections where lifting device supply line 556 is in communication with second high pressure pipe 510 and lifting device return line 540 is in communication with high pressure pipe 388'. If, however, the solenoid valve power switch 572 is instead in its closed state, i.e., the raising state, then power is then supplied to valve controller 586, and as a result, the valve controller 586 maintains the four-way valve 584 with its corresponding connections where lifting device supply line 556 is in communication with high pressure pipe 388' and lifting device return line 540 is in communication with second high pressure pipe 510. In addition, needle valves 580 and 582 can be adjusted to reduce the flow rate within lifting device supply line 556 and lifting device return line 540, respectively, thus affecting the speed at which the seat raises and lowers. In sum, depending on the current state, i.e., a raising state or a lowering state, high pressure pipes 388' and 510, are either high and low, or low and high, respectively. Further, it is contemplated that a safety reversing mechanism, not

too dissimilar to those used in conjunction with automatic garage doors, may be utilized with this embodiment for the purpose of halting downward movement of the mechanism when a solid foreign body is detected as being present below such mechanism.

[00100] Lifting device 28""", capable of providing a pull force (towards a piston head) or a push force (away from a piston head) to a connecting piston rod depending which of the two high pressure pipes 388' or 510 contains high pressure and which contains low pressure, as determined by fluid control system 94". A push force will raise the seat during a seat raising state and a pull force will lower the seat during a seat lowering state. In the seat raising state, i.e., where high pressure pipe 388' contains high pressure and second high pressure pipe 510 contains low pressure, the preferred self-pressurized embodiment operates similarly to that of the alternative laterally offset retrofit embodiment H. Here, the high pressure hydraulic fluid from high pressure pipe 388' flows through "T" connector 366' into control pipe paths 388A' and 388B', and then into lifting actuators 28A' and 28B' causing a force to be applied to piston head front surfaces 506A and 506B and down (push force) the respective lifting piston rods 386A' and 586B′, causing such piston rods to extend outwardly away from the respective lifting actuators. What is not similar about the seat raising state of operation of the operation of the self-pressurized system to that of the similar operation of the alternative laterally offset retrofit embodiment H is the presence and displacement of the hydraulic fluid located on the rod side of piston heads 504A and 504B. As the piston rods 386A' and 586B′ extend outwardly away from their respective lifting actuators, and the piston heads 504A and 504B down their respective lifting actuators, the fluid behind such piston heads, i.e., the hydraulic fluid in contact with the piston head rear surfaces 508A and 508B and in fluid communication with control pipe paths 512A and 512B, is forced out of the lifting actuators into control pipe paths 512A and 512B, through "T" connector 588, into second high pressure pipe 510, through four-way valve 584, through lifting device return line 540 and into hydraulic fluid reservoir 528.

[00101] When the self-pressurized system is in the seat lowering state, i.e., where second high pressure pipe 510 contains high pressure and high pressure pipe 388' contains low pressure, it operates significantly differently than the alternative laterally offset retrofit embodiment H. Here, the high pressure hydraulic fluid from second high pressure pipe 510 flows through "T" connector 588 into control pipe paths 512A and 512B, and then into lifting actuators 28A' and 28B' where the high pressure hydraulic fluid pushes on piston head rear surfaces 508A and 508B causing a force to be applied up (pull force) the respective lifting piston rods 386A' and 586B′, causing such piston rods to retract inwardly towards their

respective lifting actuators. As the lifting piston rods 386A' and 586B′ move up their respective lifting actuators, fluid in front of piston heads 504A and 504B, i.e., fluid in contact with respective piston head front surfaces 506A and 506B and in fluid communication with respective control pipe paths 388A' and 388B', is forced out of the respective lifting actuators 28A' and 28B' into control pipe paths 388A' and 388B', through "T" connector 366', into high pressure pipe 388', through four-way valve 584, through lifting device return line 540 and into hydraulic fluid reservoir 528. Although, only two states, raising and lowering, are discussed above, it is contemplated that a stop, or pause, state could also be deployed. In such a state the seat could be stopped or paused anywhere along its normal path. Such a stopping or pausing could be achieved in many ways including, but not limited to, utilizing a four-way valve 584 that allows the blocking of flow between the pipes on either side of such valve or utilizing an additional valve for blocking any one or more of the pipes transferring hydraulic fluid in and out of lifting device 28"".

[0100] It is to be expressly understood that the lifting power system 30''' described with reference to FIG. 44 can replace the power systems of all the other embodiments A-H described herein. For example, power system 30''' can replace drive system 96 in the composite embodiment of FIG. 6.

[0101] Turning now to FIGS. 45, 46 and 47, alternative connections of the retrofit embodiments of the present invention are possible through the use of a hinge, generally indicated at 604. The hinge 604 comprises a fastening hinge plate 604A, a frame hinge plate 604B, and a pin 604C. As best shown in FIG. 45, the fastening hinge plate 604A includes an opening to receive the threaded bolt 602A. The threaded bolt 602A is also received through an elastomeric member 606 sealingly positioned between the horizontally positioned fastening hinge plate 604A and the upper ledge 608 of the bath 24. The elastomeric member 606 can be fabricated from rubber, neoprene, or any other gasket material that provides a seal between the fastening hinge plate 604A and the upper ledge 608. The bolt 602A is further positioned through an opening 608A in the upper ledge 608 and can use a holding portion 602B of a blind fastener, as previously proposed, when the interior portion of the bath 610 is not accessible. This is particularly important in the retrofit of conventional baths where the upper ledge 608 is sealed with the interior wall W. The frame hinge plate 604B can receive a plurality of threaded members, such as countersunk bolts 612, for securing the frame hinge plate 604B to the side member 346A of the frame 300. As can be seen in FIG. 45, there is preferably a clearance C between the frame hinge plate 604B and the back bath wall 24A.

[0102] Turning now to FIGS. 46 and 47, the hinge 604 is shown with the fastening hinge plate 604A in the vertical position. In this vertical position, the opening in the fastening hinge plate 604A allows the bolt 614 to be received through the fastening hinge plate 604A, a spacer 616, an interior reinforcing member 618, interior wall W, stud S, and exterior wall W1. The bolt 614 preferably uses washers 620 and 622, as desirable to provide distribution of the load on the bolt 614, along with a fastening nut 624. When installing the retrofit embodiment bath lifting system in the bath, the fastening hinge plate 604A is positioned so that the frame hinge plate 604B is provided sufficient clearance C' from the back bath wall 24A. This desirable clearance can be achieved by using different thicknesses and/or number of interior reinforcing members, such as member 618, different thicknesses and/or number of spacers, such as spacer 616, as best shown in FIGS. 46 and 47, or other ways known to those skilled in the art.

[0103] FIG. 47, in combination with FIG. 46, shows an example of an installation of the retrofit embodiment bath lifting system of the present invention. In particular, FIG. 46 shows the bolt 614 extending through, among other structural members, the stud S for structural integrity of the installation. FIG. 47 also shows a bolt 626 extending through washer 620', fastening hinge plate 604A', spacer 616', interior reinforcing member 618, interior wall W, open space 628 (between studs S1 and S2 and interior wall W, exterior wall W1), exterior reinforcing member 630, and washer 622'. While bolt 626, in this illustration, will need to extend the additional difference of the thickness of exterior reinforcing member 630, similar washers 620' or 622', and nut 624' used with bolt 614, could be used with the longer bolt 626. As can be best seen in FIG. 47, the reinforcing members 618 and 630 are preferably fastened to their respective studs S1, S2, and S3 by use of wood screws WS. Also, as best shown in FIG. 47, each of the frame hinge plates 604B and 604B' are preferably fastened to the frame 300 using four threaded bolts, such as threaded bolts 612 shown in FIGS. 45 and 46. The reinforcing members 618 and 630 could be fabricated from any structural stable material, such as wood, metal, plastic, or fiberglass. Also, the exterior wall W1 could be to an adjacent room wall, such as in a closet, or an exterior wall outside of the building or house. In most cases, the wall W1 would be accessible, and therefore would not require the use of a blind fastener, such as proposed above. However, if the wall W1 is not accessible, blind fasteners, as proposed above, could be used.

[0104] Turning now to FIGS. 48 and 49, a force compensation system is shown where the seat assembly 22 of the retrofit embodiment bath lifting system of the present invention engages an obstruction O. The force compensation system includes the hinges 604 and 604',

and the lifting system 28 in combination with the guiding assembly 26 and the frame 300, including illustrated frame member 346A. The force compensation system allows the frame 300 to pivot about hinges 604 and 604' away from the back bath wall 24A, so that the frame 300 also moves away from the bath bottom 24E, as best shown in FIG. 49. This force compensation system can be activated intentionally (e.g., for cleaning the back bath wall 24A adjacent the frame 300), or could be activated unintentionally (e.g., where the obstruction could be the leg of the user of the bath lifting system). In either case, when the seat assembly 22 or its associated seat bracket 46 come into contact with any obstruction O, the force compensation system will react to a force F hindering the seat assembly 22 or its seat bracket 46 from moving to its lower position. Because of the hinge 604 and 604', the lifting device 28, while continuing to retract, will pull the frame 300 away from the bath bottom 24E. In other words, the force compensation system, including the lifting device 28 and the hinges 604 and 604' in combination with the guiding assembly 26 and the frame 300, compensates for the force F by allowing the lifting device 28 to continue to retract by pivoting the hinged frame 300.

[0105] As can now be understood, the force compensation system of the present invention can be used with different configurations of frames, guiding assemblies and lifting systems besides those proposed in this application.

<u>PREFERRED LATERALLY OFFSET RETROFIT EMBODIMENT J</u>

[0106] FIGS. 50-54 illustrate preferred laterally offset retrofit embodiment J. Similar to the alternative laterally offset retrofit embodiment H of FIGS. 36-43, the preferred laterally offset retrofit embodiment J includes a frame, generally indicated at 300‴, a seat assembly, generally indicated at 22″, a guiding assembly, generally indicated at 26‴, a lifting device, generally indicated at 28″, and a lifting power system, generally indicated at 30⁗. The preferred laterally offset embodiment J is intended to be compatible with a majority of standard baths, old or new. In addition, the proposed embodiment J contemplates the subsequent removal of the proposed system from such baths while leaving them in substantially the same condition as they were in pre-installation. Unlike alternative embodiments D and H, which move the seat assembly 22″ upwards and forwards, the preferred laterally offset retrofit embodiment moves the seat upwards and rearwards. This allows retrofitting the preferred embodiment J in existing baths that may be too short for use with the alternative embodiments D and H.

[0107] FIGS. 50-54 illustrate the proposed system in a bath in which entry and egress is from the bather's right side when sitting in the bath. Because in many installations, entry and egress from the bather's left side is required, the preferred embodiment J is designed to be manufactured so that the proposed system can be assembled for installation in baths with either direction of entry and egress, without requiring a different inventory of parts for each direction. Reversal of the parts for the frame 300‴, guiding assembly 26‴, and lifting device 28″ prior to assembly to a mirror-image configuration converts the proposed system between orientations. This guiding assembly 26‴ can also reduce manufacturing costs, as it requires fewer parts and is typically easier to assemble than the alternative retrofit embodiments described above.

[0108] As best shown in FIG. 51, frame 300‴ includes two side members 346A‴ and 346B‴, two bottom members 348A‴ and 348B‴, and two cross members 342′ and 344′. The two cross members 342′ and 344′ have a length that allows frame 300‴ to fit within standard bath widths, and to provide sufficient stability during high torque activities, such as when seat assembly 22″ is occupied with a bather and is swiveled to extend over the side of bath 20′, rather than between such frame side members 346A‴ and 346B‴. The side members 346A‴ and 346B‴ are typically made of angle irons, but can be made of any other suitable material desired.

[0109] As with alternative embodiments D and H, the proposed system is designed for use with a bath 20′ with a back angle less than 30° from vertical, with side members 346A‴ and 346B‴ substantially parallel with the back wall 24A′ of the bath 20′ at least connected to the top of the back wall 24A′. The bottom members 348A‴ and 348B‴ rest on the bath bottom substantially parallel to the bottom 24E′ of the bath 20′. Cross members 342′ and 344′ are attached as shown in the FIGS to the side members 346A‴ and 346B‴ or bottom members 348A‴ and 348B‴ for structural rigidity, at any desirable location, but preferably at the top and bottom of the frame 300‴.

[0110] As illustrated in FIG. 50, frame 300‴ can also include a pair of intermediate members 347A‴ and 347B‴, connecting side members 346A‴ and 346B‴ with bottom members 348A‴ and 348B‴ at an angle. As shown, this configuration allows additional clearance between the back wall 24A′ and bottom 24E′ of the bath 20′, providing additional clearance for installing the proposed system in a larger variety of baths.

[0111] Although not shown in FIGS. 50-54, the rubber feet 350A and 350B illustrated in FIGS. 14 and 15 can be attached to bottom members 348A‴ and 348B‴ or cross member

342′, as with the alternative retrofit embodiments, for protection of the surface of bath 20′ and for cushioning.

[0112] Frame 300‴ is secured to bath 20′ as best illustrated in FIG. 50 by attaching the frame 300‴ to the top of back bath wall 24A′ or wall W using the mechanisms described above in the description of FIGS. 45-49. Alternatively, frame 300‴ can be secured to bath wall 24A′ with fasteners as described above in the description of FIGS. 13, 15, and 19.

[0113] Unlike the alternative retrofit embodiments, the frame 300‴ positions guiding assembly 26‴ at a steeper angle than the frame 300‴, allowing sufficient clearance for the seat assembly 22″ with a wall behind the bath 20′ when the seat assembly 22″ is fully raised, as best illustrated in FIG.53. As illustrated in FIG. 50, this angle is approximately 20° from the vertical, but other angles can be used. Upper support members 349A, 349B, and 349C extend forward from the frame side members 346A‴ and 346B‴ to support the guiding assembly 26‴ at the desired angle.

[0114] The preferred retrofit laterally offset embodiment J uses an upwards and rearwards linear movement when raising the seat assembly 22″, in contrast to the arcuate, including upward and forward, movement used by the alternative retrofit embodiments. In combination with the preferred 20° rearward angle, the guiding assembly 26‴ includes two U-channel members 351A and 351B, mounted at an angle Ø from the vertical with respect to the bath bottom 24E′, such that the guiding assembly 26″ guides seat assembly 22″ from a lowered position, at or near the longitudinal center of the bath, to a raised position, where seat assembly 22″ is laterally offset near side wall 24D′. As shown in FIG. 51, angle Ø is 15°, which allows seat assembly 22″, in the raised position, to be within four inches or less of the edge of the bath and provides a significant increase in convenience for getting in and out of bath 20′. As discussed above, it is contemplated that the bath 20′ could be entered from the left side, as compared to the right side as shown in FIGS. 50-53, and angle Ø can be reversed to allow seat assembly 22″ to travel towards the entry side of bath 20′ in the left bath 20′ configuration, as seat assembly 22″ moves from the lowered position to the raised position. As discussed above, the preferred laterally offset embodiment J can be manufactured for both configurations of bath 20′ with the same parts for the frame 300‴, guiding assembly 26″, and lifting device 28″ in mirror image.

[0115] This mirror-image capability is provided by forming both ends of the U-channel members 351A and 351B at angle Ø, parallel to each other, so that the bottom and top of members 351A and 351B are parallel to the bottom 24E′ of bath 20′ when attached to bottom members 348A‴ and 348B‴. By positioning the channel members 351A and 351B in mirror

image, the guiding assembly 26‴ will slant in the opposite direction. Upper support members 349A, 349B, and 349C of frame 300‴ can also be positioned in such a mirror-image configuration.

[0116] Cross member 353 of guiding assembly 26‴ provides structural rigidity for the guiding assembly 300‴. Although shown in FIGS. 51 and 52 as flat, cross member 353 can be any desirable shape and cross-section. Channel members 351A and 351B are illustrated as U-shaped channel bars, but other shapes can be used, such as a V-shaped channel, with corresponding changes to guide members 359A, 359B, 359C, and 359D, described below.

[0117] Lifting device 28‴ includes a hydraulic piston cylinder assembly 355, similar to the hydraulic cylinders used in the alternative embodiments A-H described above. The lifting device 28‴ provides lifting force to the guiding assembly 26‴, including guiding/lifting attachment members 361A and 361B, guide members 359A, 359B, 359C, and 359D, pins 373A, 373B, 373C, and 373D, side members 371A and 371B, and cross member 367. Bottom cylinder cap 383B is attached to the bottom of cylinder assembly 355 to provide an attachment point for the bottom of cylinder assembly 355 to the frame 300‴. A cylinder attachment bar 357 is welded or otherwise attached to the frame lower cross member 342′. The cylinder attachment bar is hingedly attached to the bottom cap 383B in its slot 387 formed in the center of bottom cap 383B, using a pin 381. Other techniques for attaching the bottom of the cylinder assembly 355 to the frame 300‴ can be used.

[0118] A hydraulic piston rod 389 extends through upper cylinder cap 383A, forming a piston rod end 365, which is attached to guiding/lifting attachment members 361A and 361B using pin 363 or other suitable attachment apparatus. When piston rod 389 extends upwardly, guiding/lifting attachment members 361A and 361B lift cross member 367 and side members 371A and 371B, causing guide members 359A, 359B, 359C, and 359D to rise through the channel members 351A and 351B, guiding the lifting device along the channel members 351A and 351B. Seat assembly 22″, is attached to lifting device 28″ by seat bracket 46, which is attached to the bottom end of side members 371A and 371B. Thus, extending and retracting piston rod 389 raises and lowers the seat assembly 22″, including seat 22A″.

[0119] As illustrated in FIGS. 50-53, guide members 359A, 359B, 359C, and 359D are substantially cylindrical rollers, rotating around respective pins 373A, 373B, 373C, and 373D while moving within channel member 351A and 351B. Other shape rollers can be used as guide members 359A, 359B, 359C, and 359D, corresponding to different cross-sectional configurations of channel members 351A and 351B. Alternatively, guide members 359A, 359B, 359C, and 359D can be fixed guide members, slidably interengaging with the channel

members 351A and 351B. Preferably, such fixed guide members are constructed from a low friction elastomer or nylon, to avoid sticking problems when moving along the channel members 351A and 351B. Although as shown in FIGS. 50-53 with the open side of channel member 351A facing the open side of channel member 351B and side members 371A and 371B positioned between channel members 351A and 351B, channel members 351A and 351B can be oriented with the open end of the U of channel member 351A facing away from the open side of channel member 351B, with guide members 359A, 359B, 359C, and 359D mounted on side members 371A and 371B positioned outward of channel members 351A and 351B.

[0120] As described above in detail and shown in the FIGS., seat assembly 22″ can rotate on seat base 306 for entering and exiting the bath.

[0121] FIG. 53 shows the seat assembly 22″ in a fully raised position, with piston rod 389 fully extended. In the raised position, a portion of the side members 371A and 371B extend above the hydraulic cylinder assembly 355, but remain hidden behind seat back 22B″.

[0122] Although illustrated in FIGS. 50-53 with a fixed arm rest 320, the preferred embodiment J can be configured with the telescoping arm rest 320′ and arm rest bracket 322′ of FIGS. 38 and 39 described above on either or both sides of the seat 22A″, as desired.

[0123] Turning now to FIG. 54, a motorized pump lifting power system 30″″ of the preferred embodiment J can be controlled by a remote control transmitter 710. Pressing or engaging a "down" button or switch 712 on the transmitter 710 signals transceiver 715, while pressing or engaging an "up" button or switch 714 signals transceiver 720. Transceivers 715 and 720 can be wireless plug-in receivers such as the Westek Model RFA 110 receiver, configured to work with transmitter 710, which can be a Westek Model RFA 114. Other types and models of transceivers and transmitters can be used. Transceivers 715 and 720 are powered from a 110 VAC power source 705. Although shown as two separate units 715 and 720, transceivers 715 and 720 can be implemented as a single unit capable of receiving both the "up" and the "down" signal from transmitter 710.

[0124] Transceivers 715 and 720 inductively control three-pole relays 725 and 730, respectively. One example of such a relay is the ABB 1EC Contactor. Relays 725 and 730 are protected by a 7 amp fuse 740 or other similar device, such as a Ferraz GDL 250 VAC time delay 7 amp glass fuse. Interlock 735 mechanically and electrically prevents simultaneous engagement of both relays 725 and 730, preventing burnout of motor M should the operator press buttons 712 and 714 at the same time. One example of such an interlock is the ABB Interlock switch model VE5-1.

[0125] Depending on which of relays 725 or 730 is engaged, bi-directional motor M is powered to turn in the appropriate direction to power hydraulic pump P for lowering or raising, respectively, the seat assembly 22″ through the lifting device 26″, as described above. The pump P pumps hydraulic fluid into the top cap 383A of the hydraulic cylinder 355 for lowering the seat assembly 22″ and into the bottom cap 383B of the hydraulic cylinder 355 for raising the seat assembly 22″. One example of such a bi-directional pump is a Parker Oildyne Power Unit Model 108HA25-CLB-1VT-12-12, which is a 1/3 HP unit; however, other such pumps can be used as desired. Hydraulic fluid lines, not shown, connect pump P to the hydraulic cylinder assembly 355 described above for FIGS. 50-53.

[0126] The motorized pump lifting power system 30″″ can be installed in another room, inside the enclosure of the bath 20′, or behind a wall of the room containing the bath, preserving the esthetic appearance of the bath enclosure. These locations are illustrative and exemplary only, and the lifting power system 30″″ can be installed in any convenient location. In addition, the motorized pump lifting power system 30″″ can be manufactured using relatively smaller components, providing a relatively miniaturized lifting power system configuration, allowing installation in small spaces.

USE AND OPERATION OF PREFERRED EMBODIMENT J:

[0127] The bather mounts and dismounts seat assembly 22″ in the same manner as described above in the alternative laterally offset and straight up retrofit embodiments. The bather uses the remote control transmitter 710 to raise and lower the seat assembly 22″ by initiating a flow of fluid into or out of the hydraulic cylinder 355, with the assistance of pump P, as best shown in FIG. 54, causing the lifting device 28″ to raise and the seat assembly 22″ as described above.

[0128] The use of motorized pump P allows the proposed system to provide a smooth ascent and descent of the seat assembly 22″ to any position along the guiding assembly 26″, from fully raised to fully lowered, as well as any intermediate position. In addition, the motorized pump P allows use of the proposed system in situations where the unaugmented available water pressure would be insufficient to raise or lower the bather safely, such as when the bather is an obese person. However, where sufficient water pressure is available, a self-pressurized system or an unaugmented water pressure system without a pump such as described above for the alternative embodiments can be used to provide motive power for the preferred retrofit embodiment J.

[0129] The force compensation system described in detail above and illustrated in FIGS. 48-49 can also be provided with the preferred embodiment J. The force compensation system includes the hinges 604 and 604′, and the lifting system 28″ in combination with the guiding assembly 26″ and the frame 300‴, including illustrated frame member 346A‴. The force compensation system allows the frame 300‴ to pivot about hinges 604 and 604′ away from the back bath wall 24A, so that the frame 300‴ also moves away from the bath bottom 24E. As described above, this force compensation system can be activated intentionally (e.g., for cleaning the back bath wall 24A adjacent the frame 300‴), or could be activated unintentionally (e.g., where the obstruction could be the leg of the user of the bath lifting system). In either case, when the seat assembly 22″ or its associated seat bracket 46 come into contact with any obstruction O, the force compensation system will react to a force F hindering the seat assembly 22″ or its seat bracket 46 from moving to its lower position. Because of the hinge 604 and 604', the lifting device 28″, will pull the frame 300‴ away from the bath bottom 24E. In other words, the force compensation system, including the lifting device 28″ and the hinges 604 and 604′ in combination with the guiding assembly 26″ and the frame 300‴, compensates for the force F by allowing the lifting device 28″ to continue to retract by pivoting the hinged frame 300‴.

PREFERRED COMPOSITE EMBODIMENT:

[0130] It is contemplated that a preferred composite embodiment uses a bath 20‴ as described above with respect to alternative embodiment G, together with the guiding assembly, lifting device, and lifting power system of the preferred laterally offset retrofit embodiment J as described above. Use and operation of the preferred composite embodiment would be similar to that of the preferred retrofit embodiment J.

[0131] The foregoing disclosure and description is intended only to be illustrative and explanatory thereof. To the extent foreseeable, various changes in the size, shape, and materials, as well as in the details of illustrative construction and assembly, may be made without departing from the spirit of the invention.